POWER

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The Perils of Prosperity

GEORGE WASHINGTON in his Thanksgiving proclamation of 1797, with remarkable foresight recommended the people to beseech the kind Author of their blessings graciously to preserve them from the arrogance of prosperity and from hazarding the advantages they enjoyed by delusive pursuits.

Calvin Coolidge, in a recent address said: "We have demonstrated that we were able to meet adversity and overcome it. The test that now confronts the nation is prosperity. There is nothing more likely to reveal the soul of a people. History is littered with stories of nations destroyed by their own wealth."

In what way does prosperity undermine the morale and lower the stamina of a people?

It would appear that a people who were well clothed and housed and nourished, who had an abundance of time for self-culture and the finer things of life, would have the inside track in the race for the survival of the fittest.

Of course, a nation reared and trained for conquest and urged to it by avarice and a desire for a place in the sun, would find an easy victim in a people who had devoted themselves to the arts of peace and to the enjoyment of the fruits of their industry.

But this is the advantage that the armed thug has over the peaceful citizen. I doubt if that is what these two Presidents had in mind one hundred and thirty years apart

Wealth will never be equally distributed, and it ought not to be. He who serves best, in the largest way, and produces most is entitled to the largest return.

The officers' table will always be better furnished than the privates' mess.

There will always be few generals and a host of privates. The most the private can ask is a good living for the rank and file and a fair chance at the generalship.

Most possessors of great wealth and leaders of industry lead circumspect lives, maintain cultured homes and raise respectable families.

I wonder if the Father of his Country foresaw the arrogance with which some of the products of our prosperity are flaunting their wealth in utter disregard of morality, the conventions, the courts, the law, peace and dignity of the commonwealth and the demoralization of the people; the insidious processes for the anesthetization of the exploited, employed by the possessors of privilege and power.

Propeller Pumps

Proposed for

Condenser Service

By RUSSELL K. ANNIS
Pump Division, Fairbanks, Morse & Company

CHARACTERISTICS of the propeller- or screw-type pump and of the centrifugal pump are compared, and suggestions are made for applying the former to condenser service.

AN EDITORIAL in a recent issue of *Power* suggested that the propeller pump, now in general use in irrigation and drainage districts, might be a suitable piece of equipment to pump circulating water through the condensers of large modern power plants. There are many arguments in favor of the use of the propeller pump in connection with condensers.

The best-known use of the propeller pump is in drainage work. For this class of service it is known as a "screw" pump, and its outstanding advantage is its ability to pump efficiently large volumes of water against low heads. There are power plants being built today whose capacity is large enough to warrant the use of screw pumps for condenser circulation water, and the screw pump has been developed to such a degree as to indicate the practicability and economy of this application.

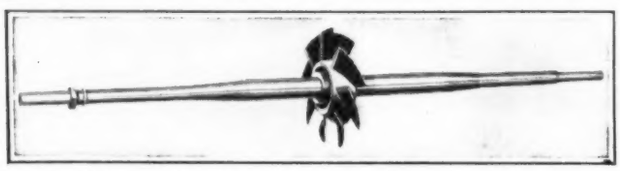


Fig. 1—Impeller of reversible screw pump

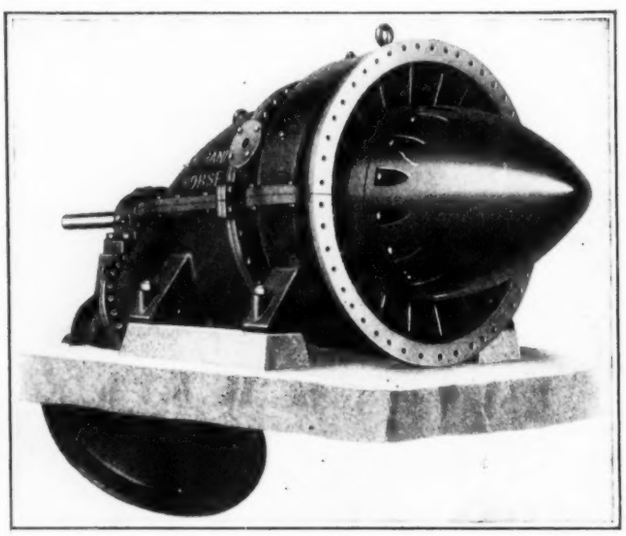


Fig. 2—Looking into the discharge end of a screw pump

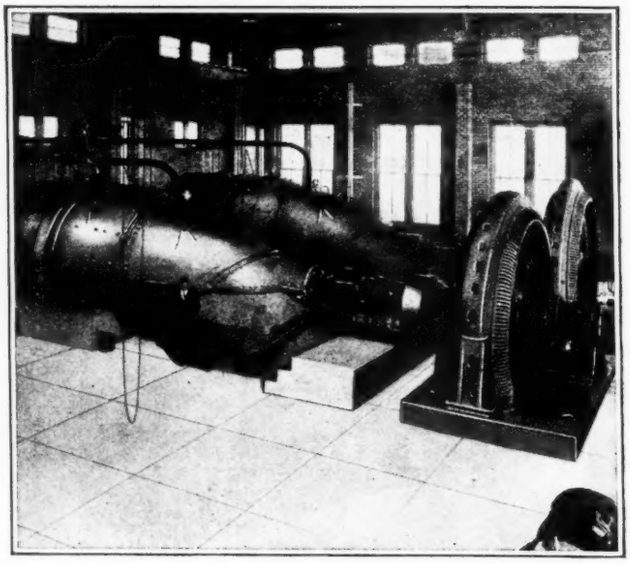


Fig. 3—Two screw pumps in New Orleans drainage pumping station

The largest installations of screw pumps in the world are in the City of New Orleans, where severe tropical storms falling over the entire area of the city are successfully pumped into Lake Pontchartrain, which empties into the Gulf. These pumps were designed by A. B. Wood, of the New Orleans Sewerage and Water Board, and the first units were installed there in 1913. Today there are eleven pumps in the City of New Orleans, and they have served the city with credit to themselves and to their designer. The recent high-water level in the Mississippi Valley put a strain on the drainage system of New Orleans never before reached nor expected, and these pumps successfully withstood the demands placed on them.

Each 12-ft. pump has a capacity of 600 to 800 cu.ft. of water per second against heads varying from nothing to twelve feet. The suction and discharge openings are twelve feet in diameter, and an idea of the size of these units is shown in Fig. 3.

SMALL PUMPS LOSE SUPERIORITY

In the smaller sizes the screw pump begins to lose its superiority over the centrifugal. Yet units as small as 30 in. in diameter are in successful operation delivering in the neighborhood of 20 cu.ft. of water per second. Models as small as 12 in. in diameter have been built and operated on the test floor, but it is doubtful whether this size will ever be used commercially. There is some possibility that the 24-in. size might be a commercial success.

It is possible to conceive of such a pump, direct connected to a motor running at 900 or 1,200 r.p.m. with an efficiency of 70 to 80 per cent and operating against

heads as low as six to ten feet or even lower. These figures, of course, are purely conjectural. They are given for the purpose of showing the range within which a screw pump might be applied. Larger sizes would have even a wider range of application.

It is difficult to predict in any but a general way just what range would be practicable, owing to the wide variation in requirements for condensers of different types and sizes and local conditions of head and methods of cooling. Screw pumps also cover a wide range, and that is why there is reason to believe there are many plants in which they could be used to advantage.

Submergence is not at all a necessity for proper operation. On the contrary, with the usual arrangement in drainage work the pump is placed on top of a levee, and in this location every internal part of the pump, including the discharge, is under a partial vacuum. The writer has seen a vacuum gage reading 28 in. in the top of the casing of the 12-ft. pumps in New Orleans with the pumps in operation.

Arrangement of Pump Parts

The suction pipe, the pump shell and the discharge pipe are arranged in such a way as to form a continuous-flow passageway with easy bends, as shown in Fig. 5. The pump is primed through a priming connection in the highest point of the casing, and a rotary or reciprocating vacuum pump extracts the air, causing the pump to be filled through the main suction and discharge pipes, which are submerged in their respective basins in order to seal against any influx of air, either when priming or when running. This arrangement forms a siphon, and when the power is shut off the water would flow backward into the suction basin were it not prevented from doing so by breaking the vacuum through a vent provided for the purpose. It is customary to break the vacuum before shutting off the power; and in starting up, the pump is primed after it is brought up to speed. This is the empty-start method and is preferred where synchronous motors are used because the starting torque required for the empty pump is very low.

The vacuum method of priming, and the location of the pump in such a way that the lowest internal part is safely above the water level of the discharge basin, accounts for the absence of foot valves, check valves and gate valves. This is made possible by the small body diameter of the pump. An equivalent centrifugal pump would have a large sweeping volute surrounding the impeller; and the impeller itself would be much larger than the rotor of a screw pump. The centrifugal

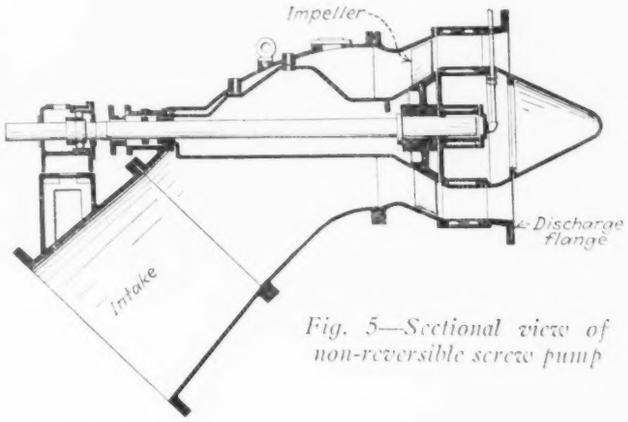


Fig. 5—Sectional view of non-reversible screw pump

placed on the same foundation as the screw pump would extend so much higher at the top that a vacuum would be formed, which would cause cavitation. A comparison between a centrifugal and a screw pump is shown in Fig. 4.

The screw pump for low-head service has many advantages. From the viewpoint of hydraulic design alone there are several marked points in its favor. The straight line flow through the pipe connections and the pump casing, the comparatively high speed, the steep characteristic curve, which indicates little change in capacity over a wide range of head, and the flat efficiency curve, are commendable features.

Perhaps the statement that the speed is high is misleading. This is true only by comparison with an equivalent centrifugal pump. In fact the speeds at which screw pumps operate are sometimes not even as high as might be desired, but they are higher than for centrifugals for the same class of service. The possibilities of even higher speeds have not been exhausted. The 12-ft. pumps in New Orleans operate at only 83 r.p.m., but if it were possible to design a centrifugal pump to handle half a million gallons per minute against the same low heads, the speed would probably be less than half that of the screw pump. Smaller screw pumps operate at 257 r.p.m. to accommodate oil-engine speeds. It might

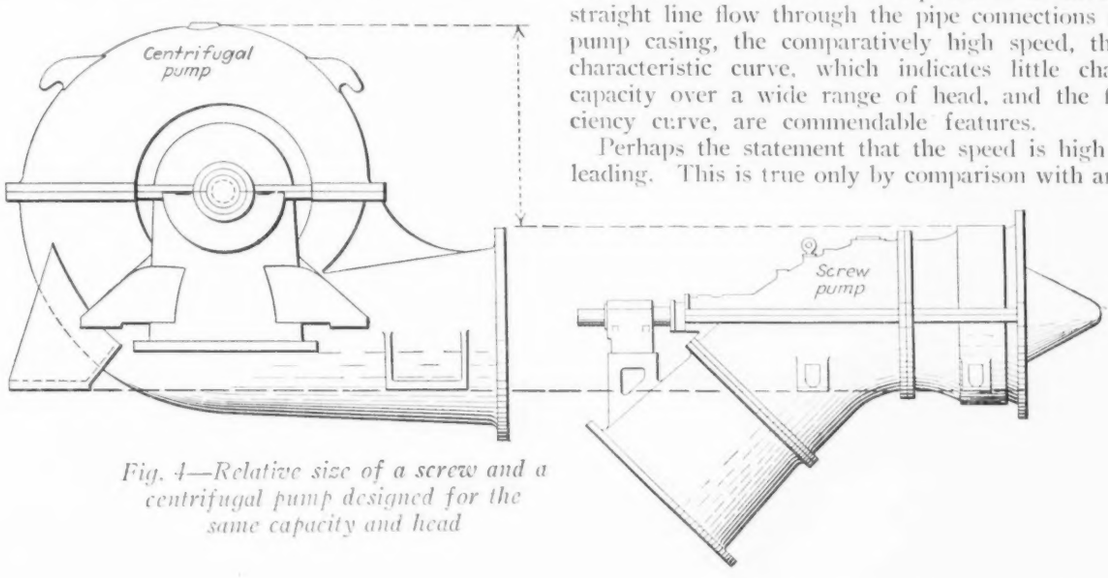


Fig. 4—Relative size of a screw and a centrifugal pump designed for the same capacity and head

be possible to design a 24-in. or a 36-in. screw pump to operate at commercial 60-cycle motor speeds, and deliver condenser cooling water against low heads with good efficiency.

The test curves of a screw pump reveal its unusual performance. Fig. 6 shows the conventional curves of a centrifugal pump, while Fig. 7 shows the curves of a

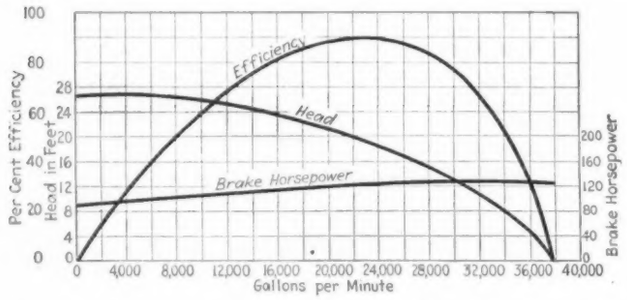


Fig. 6—Characteristic curves of a 36-in. double-suction 224-r.p.m. centrifugal pump with a Francis runner

screw pump. The head curve or "characteristic" of the screw pump is much steeper than for a centrifugal pump. This is not due to the method of plotting the curves, nor to the conditions under which they were tested. It is an inherent quality of the screw pump, and it has a shut-off head more than double the most efficient working head.

At all points the horsepower curve of the screw pump has a downward slope. The downward slope at the extreme right end is of marked importance, because it indicates that a saving in power results when operating against reduced heads. Some centrifugal pumps do this to a certain extent, but not so definitely as the screw pump curve shown here.

The realm of the screw pump is defined by low heads and large capacities. Fig. 8 has been plotted to show this in comparison with a centrifugal. In Fig. 8 the centrifugal pump has been given every advantage, yet

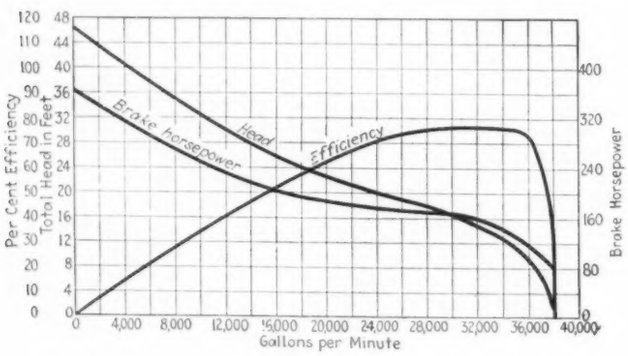


Fig. 7—Characteristic curves of a 42-in. 360-r.p.m. screw pump

the screw pump with the handicaps that have been imposed has come out the victor.

Fig. 8 is unusual in that the values for heads are used as abscissas. This was done in order to make a direct comparison between the two pumps and to show this comparison graphically. In order to illustrate the simplicity of this representation, read the capacity at, say, eight-foot head on Fig. 6, which is 34,000 gal. per min. at an efficiency of 54 per cent. Similarly, on Fig. 7, the capacity at eight-foot head is 36,600 gal. per min., and the efficiency is 69 per cent. By a roundabout way this shows that at eight feet, the efficiency of the centrifugal pump is 54 per cent, while that of the screw pumps is 69 per cent. With the aid of Fig. 8, however, the comparison is direct, and the two values for efficiency can be read without reference to capacity.

In plotting these curves the handicaps that were imposed on the screw pump should be explained. The first handicap is the selection of the sizes of pumps to be compared. The centrifugal has a 36-in. suction and discharge, while the screw pump has a 42-in. suction and discharge. At first thought the screw pump would appear to have been favored in size, but in reality it is the smaller of the two pumps. Its weight is 9,000 lb., while that of the 36-in. centrifugal is 21,000 pounds.

It will be noticed that the screw pump is running at more than 50 per cent greater speed. A centrifugal pump at 360 r.p.m. would have been completely outclassed, and yet it would not have been unfair to have compared on that basis. This was another handicap imposed for the

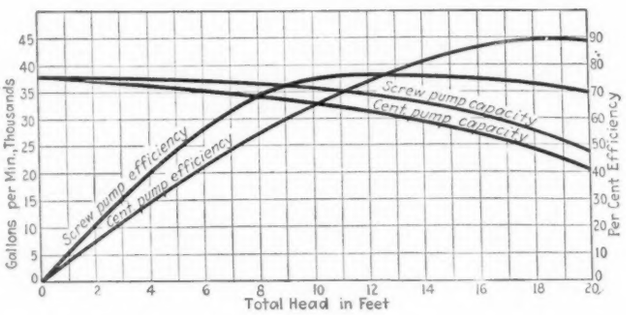


Fig. 8—Curves comparing the capacity and efficiency of the pumps, Figs. 6 and 7, at low heads

purpose of these tests in order to bring out the better efficiency of the screw pump at low heads.

The space requirements of the screw pump are small and convenient. The pump and its prime mover form a long narrow unit that stretches out in the direction of the suction and discharge canals or tunnels, and the unit is approximately the same width as the canals. The length gives the pump a good footing so that only a light foundation is required. The pump is comparatively light in weight for the duty it performs. Large savings in erection costs, floor space and building costs result in such installation.

Pump Primarily for Drainige Work

The screw pump has been designed and developed primarily for drainage work. But it ought to be possible to apply the same technical features and operating characteristics that have made it desirable in drainage work, to any class of service where large volumes of water have to be pumped against low heads. Condenser work is in this class. Every artistry of centrifugal pump designers has been brought to bear upon this problem. They have tried large, low-speed pumps, pumps with Francis-type impellers, several small, high-speed pumps in parallel and multi-impeller pumps with several impellers on a single shaft and running in a common casing. Some stations submit to a compromise, using a fairly

large pump, operating at a comparatively low speed, and accept whatever efficiency can be obtained. The goal is to design for low first cost, reasonable space, speeds adaptable to standard drives and good efficiency. The screw pump will fulfill these requirements.

Surface Condenser Applications

Fig. 9 shows a suggested arrangement in connection with a surface condenser. The pump proper, together with its motor, is placed above the intake canal and parallel to it, exactly the same as in drainage work.

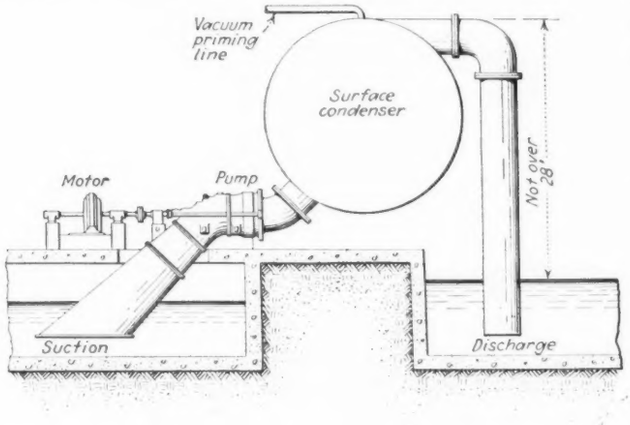


Fig. 9—Suggested arrangement of a circulating-water screw pump on a surface condenser

The discharge connection from the condenser can be straight downward into the outflow canal.

All parts of this circulating system are under a partial vacuum, and this should not be confused with the high vacuum of the condenser. A priming connection leading to a low-vacuum priming pump is located in the top of the condenser, and this pump would have to be operated occasionally during operation if there should be any tendency to collect air at this point. In starting up, the power could be applied to the screw pump, then the vacuum priming pump could be started, which will eject water when the system is primed. The circulating system will then be in operation, and the main power units can be started.

For some stations it might be more convenient to locate the condensers below the level of the water supply, and in this case the priming connection would be in the top of the pump rather than in the condenser. The operation would be the same in either case. The only limitation with respect to the location of the condenser is that the top point of the system must not be too high above the level of the water supply to allow for priming and operating with a vacuum.

Barometric Condenser Applications

Fig. 10 shows a suggested arrangement for a screw pump connected to a barometric condenser. The circulating pump for a barometric condenser is usually required to operate against a head enough to fill the system with water initially. W screw pump this would be possible, but perhaps advisable. A screw pump that has a head high enough to fill the upper portions with water will hardly have a good operating efficiency at lower heads. Yet, this is the usual requirement for a centrifugal pump when used for this purpose, and the characteristic of the screw pump being steeper, might be even better suited to this dual service. Perhaps the best line-up would be to have the air pump, which is usually connected to the top of the condenser, do the priming; and the screw pump could be designed for the one service of circulating the cooling water. This would depend on the design of the condenser and the local requirements. Once in operation, the screw pump will be required to overcome the pipe friction, plus the impulse of the jet, plus the difference in elevation between the level of the water in the tail pipe and that in the supply pipe. It is quite possible that in the average station this total head could be easily generated by a screw pump.

Range of Applications

It is difficult to define accurately the scope within which the screw pump could be applied to condenser work. In its present application the runner is made of rough cast steel to withstand the erosion of grit and the shocks of water-logged débris. Even under these conditions, efficiencies of over 80 per cent have been obtained. It is reasonable to expect even higher values with a runner of polished bronze, which would be more consistent with power-plant design. Then again, the requirements of capacity and head for different stations will not be uniform. At the present time the screw pump shows its advantages over the centrifugal at heads of fifteen feet and under, although higher heads are possible at good efficiency. The head may often be too high

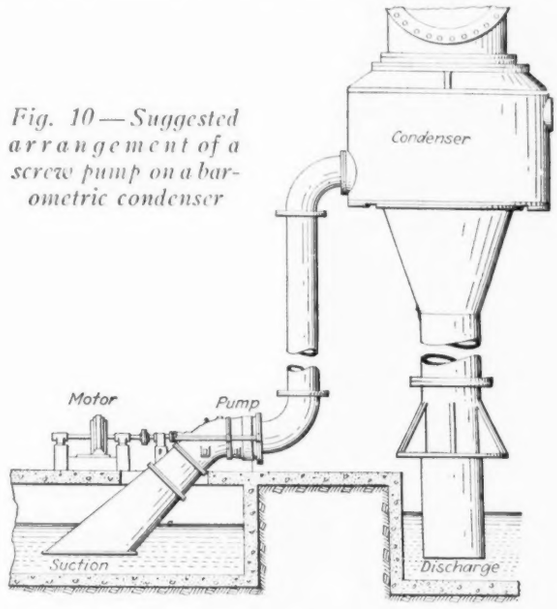


Fig. 10—Suggested arrangement of a screw pump on a barometric condenser

or the capacity too small for a screw pump to operate economically. Any capacity over 10,000 g.p.m. would be worth considering. Above this value the capacity for which screw pumps can be designed at a low head is almost unlimited.

Like many other developments in power plant design, the need for better and improved methods exists, and equipment of proved merit is known, waiting only for someone to take the first step. In this case nothing drastic is required, no groping for facts, merely the connecting up to a given duty, equipment that has shown its ability to perform that duty.

Hotel Makes Good Showing in Production of Steam and Power

By E. H. FISH and F. V. HADLEY

Improvements in plant at Copley Plaza result in steam cost of 51 cents per thousand pounds and power cost under 2 cents per kilowatt-hour

SOME six years ago the Copley Plaza Hotel in Boston found it imperative to reduce the cost of operation without sacrificing its accepted standards of service. A study of the expense accounts showed that the cost of steam had risen with and somewhat beyond the advance in the cost of coal and that it had become a serious factor in the advancing cost of operation.

Consideration was first given to the better use of coal. The stokers had been installed when the hotel was first built and had become nearly obsolete. New stokers were considered in comparison with oil burning. Suffice it to say that the superintendent became convinced that a decided improvement could be made over the oil burning equipment offered, but that such improvement might be made more rapidly than advance in stokers.

As modern hotels go, this one is small. It has accommodations for about 700 guests. The room rental load

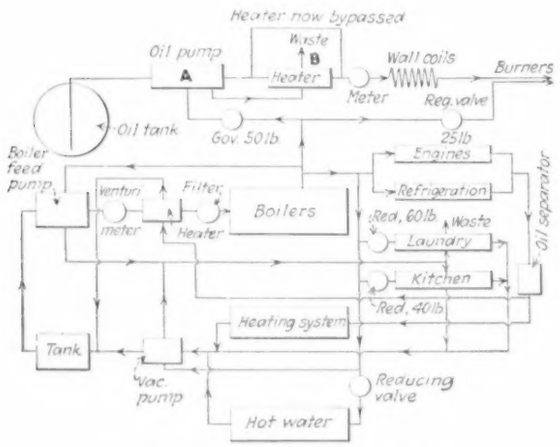


Fig. 1—Heat distribution diagram

is fairly uniform, and banquets and conventions are variable. The heating is seasonal. For coal burning it was thought necessary to install four 3,500-sq.ft. water-tube boilers. During the whole of 1924 only one boiler was in use at any one time, but since then it has been customary to keep another boiler floating on the line, because, otherwise, the one boiler would often be carried far beyond 200 per cent rating.

Steam is supplied to three single-cylinder Corliss engines, one driving a 200-kw. generator and two connected to 300-kw. machines, all direct current. The Edison circuits in that part of Boston are all direct-current, which influences private plants that may desire breakdown service. There are two ice machines whose average load is about 67 hp. Further use for live steam is found

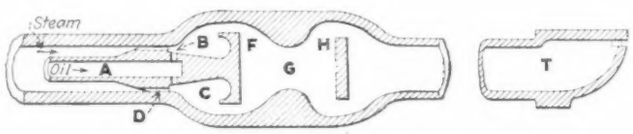


Fig. 2—Section through oil burner used at the Copley Plaza

in the boiler-feed and vacuum pumps, the oil pressure pump, for atomizing the oil and in the kitchen and laundry, but only so far as exhaust steam cannot be used. For example, in some of the kitchen apparatus the temperature of steam at 40 lb. is needed for certain cooking operations, and in the laundry, where everything must be fully sterilized, a pressure of 60 lb. is necessary to get the required temperature.

The heat distribution is indicated by the diagram, Fig. 1. The personnel of the power plant is interested in the efficiency of the hotel as a whole rather than in making a good showing for the power plant itself. No live steam is used where there is any possibility of using steam that has already done some useful work. Nor is the latent heat of steam that has done useful work wasted if there is a place to use it for heating of any kind. Referring again to Fig. 1, live steam goes first to the boiler feed pumps, the oil pressure pump and to the burners for atomization. The main line is to the engines, the ice machines with reducing valves to the kitchen, laundry and hot-water heating system. A bypass with reducing valve is provided for heating the house, but it is not shown here because it is so seldom used. Exhaust from the engines, ice machines, pumps, etc., is also used in the kitchen and laundry, the house heating system and feed-water heater.

Condensate from the exhaust steam that goes through the laundry is wasted, because of the soap, dirt and lint that it contains. The exhaust from the oil pump is used to partly heat the oil for the burners and is then wasted as being too small to justify the expense of saving. The oil is still further heated by passing through coils between the furnace lining and the outer walls. This last heating is accomplished close to the burners and for

each burner, without cost, as this heat is not otherwise reclaimable. The heated oil passes under pressure into the mixing chambers through tube *A*, Fig. 2, and out through a number of small holes *B*. Steam at about 25 lb. enters through the larger pipe surrounding the oil tube, so that the temperature of the oil at the mixing chamber is presumably nearly that of the steam or around 250 deg.

This steam passes into the first mixing chamber through the slots *D*, which are fashioned after Venturi tubes. The steam thus passes over the outer ends of the oil holes *B* and helps to add to the flow of oil caused by the pressure pump. The mixed oil and steam is swirled about in chamber *C* by the curved baffle *F*. The mixture is compressed through neck *G* and re-expanded in chamber *H*, where it again meets a baffle plate, and then, slightly compressed, it flows to the tip or nozzle *T*, from which it escapes and burns in the firebox. The volume of the flame is controlled by a specially designed reducing valve set next to each burner, the nature of the flame is dependent on the relative areas of the Venturi outlets and the oil holes *B*, and also on their relative positions, while the shape of the flame is regulated by the shape of the slot, or mouth of the tip. The construction of the burner is such that these parts can be readily removed.

The cost of running the burners themselves includes the cost of running the oil pump and the water wasted by it, the water used for atomization, which probably goes up the chimney, and the cost of fuel to make into steam that which is necessary for atomization. For the year 1926 these were as follows:

Cost of power for oil pump	$12.38
Cost of water wasted from pump	33.60
Cost of water wasted by atomization	23.08
Cost of fuel for atomization	419.85
	$488.91

Referring to the figures given later, it will be seen that this adds to the cost of steam a trifle less than one-third of a cent per thousand pounds (0.00326).

The table gives the monthly log for 1926. The amount of water delivered to the boiler is determined by a Venturi meter, and the oil is metered. Readings are taken every watch. The water and oil meters were both carefully calculated by the manufacturers just prior to the beginning of 1926. Evaporation is actual, corrected evaporation is 1.0462 times the actual, steam being made at 125 lb. gage from feed water at 210 deg. No account has been taken of the fact that the steam has a few degrees of superheat.

Assuming that the oil contains 18,500 B.t.u. per gal. and that it weighs full 8 lb. per gal. (tests show 18,350 and 7.98) the average efficiency of boiler and furnace for the year was over 81 per cent. The lowest month was August at 79.8 per cent and the highest, June at 83.1 per cent. These two months will probably always be the lowest and highest, as August is the month that brings few except automobilists passing through and June is the month of commencements for the numerous colleges with which Boston is surrounded.

While we are concerned here with the manufacture of steam, it is of interest to know that in spite of the use of non-condensing engines, low steam pressure, etc., the actual cost of power used was a shade under 1.9c. per kilowatt-hour after charging interest on investment, depreciation, rent of space used, as well as actual operating costs. It should be borne in mind that this gives the hotel steam for heating the house, its hot-water supply and steam for kitchen and laundry for much less than if the power were purchased.

Tests have been made and the results worked out by two students[1] of the Massachusetts Institute of Technology, which show that if steam for these purposes was charged to the hotel for what it would cost to make it without going through the engines, the cost of power at the busbars would be only 1.5c. per kilowatt-hour. Cost of steam leaving the boiler less that used for the burners was found by them to be 51c. per thousand pounds. This includes all makeup water, even that wasted in kitchen and laundry, and at city water rates.

BOILER ROOM PERFORMANCE FOR 1926

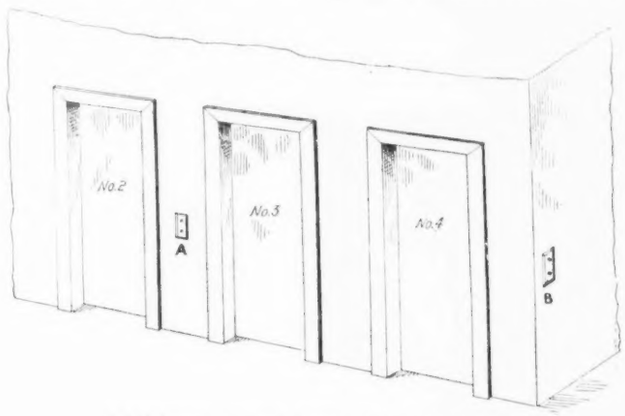
	Pounds Feed Water	Gallons Oil	Evaporation	Corrected Evaporation
January	13,585,000	113,735	14.8	15.49
February	12,252,000	104,329	14.68	15.36
March	12,659,000	106,154	14.91	15.59
April	12,441,000	103,633	15.005	15.7
May	12,922,000	107,865	14.975	15.67
June	11,914,000	98,678	15.09	15.79
July	11,990,000	99,600	15.05	15.74
August	11,402,000	98,217	14.5	15.17
September	11,495,000	97,015	14.58	15.25
October	12,411,000	105,476	14.875	15.56
November	12,487,660	106,621	14.64	15.32
December	14,071,000	118,831	14.8	15.48

The conclusion to be drawn from this experience is that even a relatively small plant may attain high efficiencies by attention to details.

Speeding up Elevator Service

By R. C. Martin

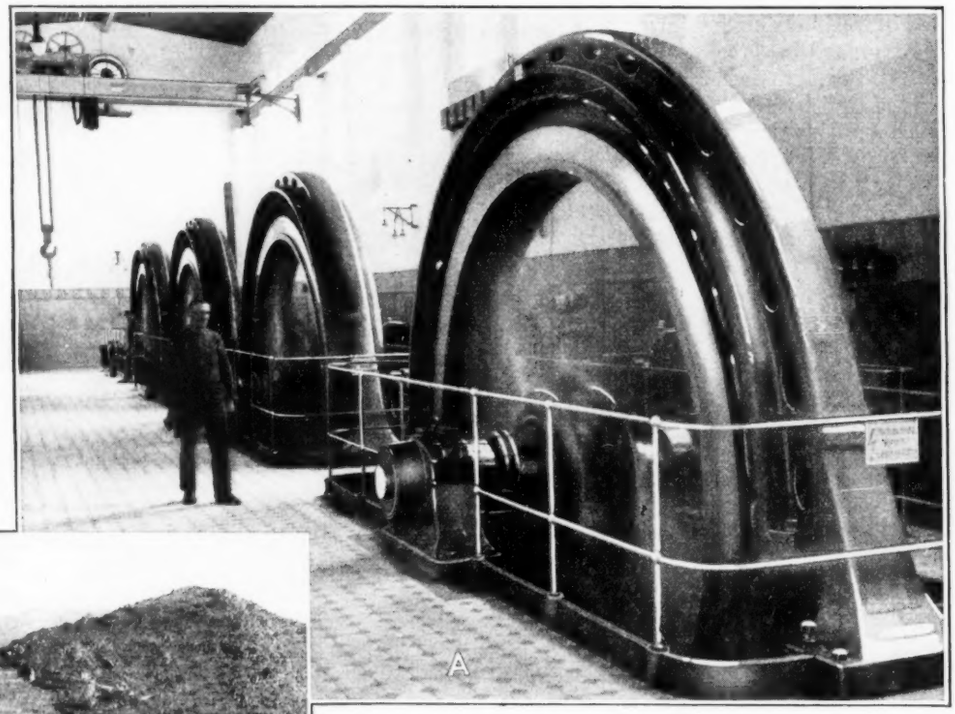
IN OUR biulding it was found that employees frequently arrived at the elevator landing at just about the time a car passed the floor in the direction they wished to go. There were four elevators in the bank and a corridor run at right angles to the landing, as is common in many buildings. The signal buttons were located between the landing doors of No. 2 and No. 3 cars, as shown at *A* in the figure.



Additional signal buttons located at "B"

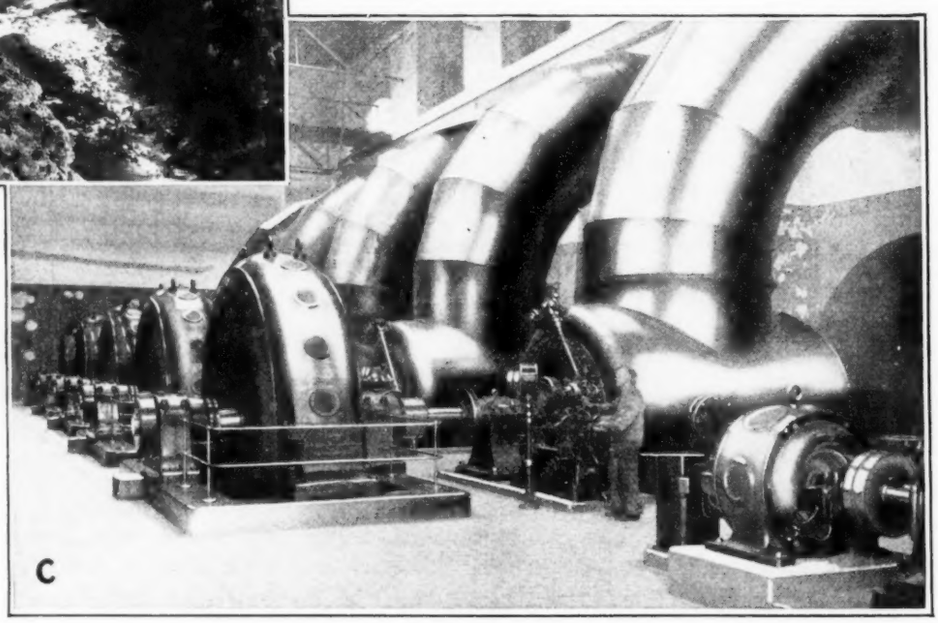
To make these buttons more convenient to those using the elevators, a second group was placed in the corridors just around the corner from the elevator landing as at *B* in the figure. These buttons were connected in parallel with the landing buttons, which made it possible for those coming down the corridors to signal the elevator operators before they actually arrived at the landing doors. This arrangement has worked out satisfactorily and has resulted in a saving of time.

[1] A. Anderson, Jr. and A. C. DeNapoli, Jr.

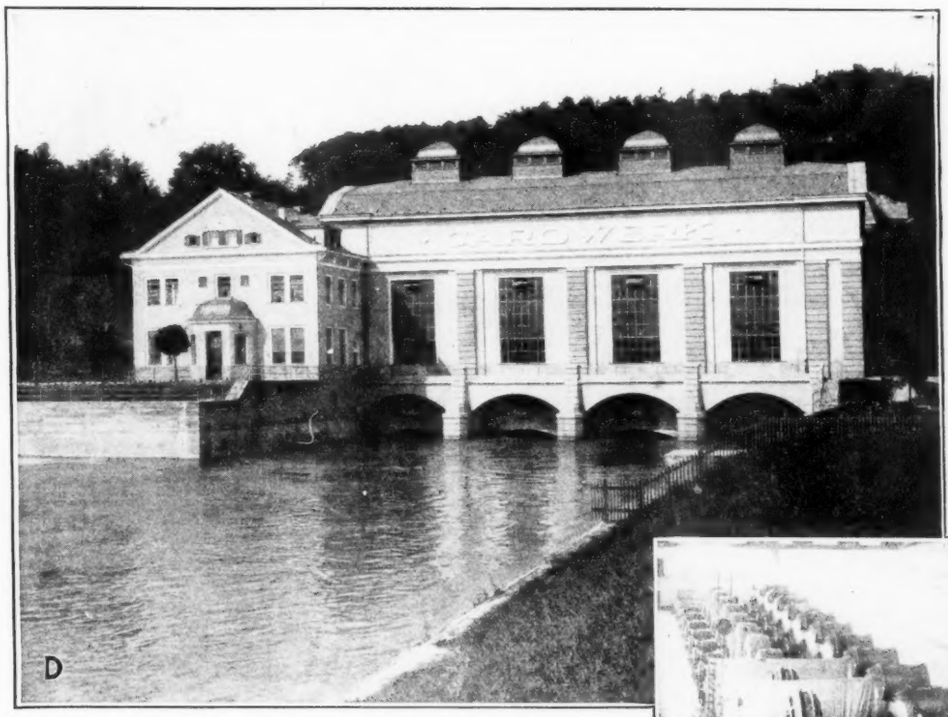


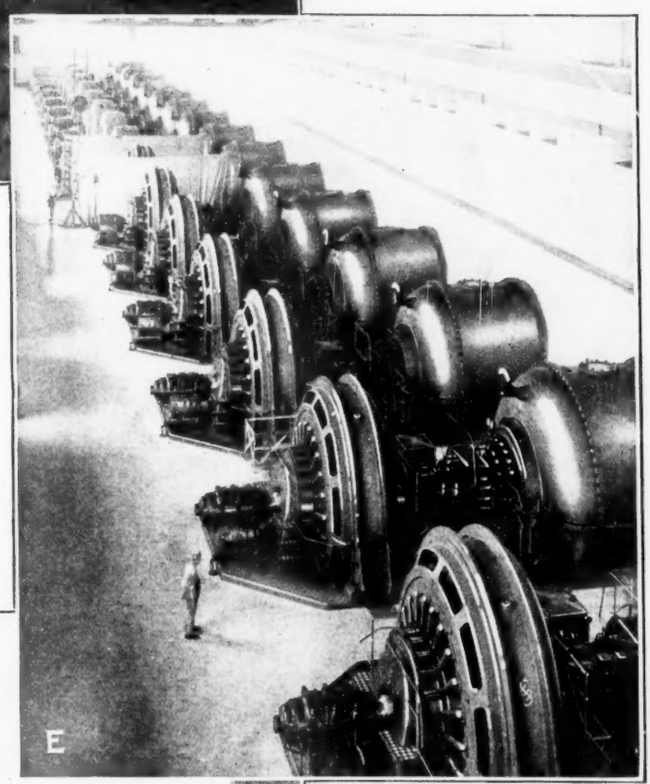
Some Modern European

Power is occupying an important place in the economic reconstruction of Europe. In Germany large water-power construction programs are under way to at least in part compensate for some of the coal fields lost after the war. The plants shown at A, C, D *and* E *are representative of some of the installations. The three first named are in one development on the Altz River in*



Plant B *is representative of some of the installations in the French Alps. This plant is located in the Gorge Du Doux.*

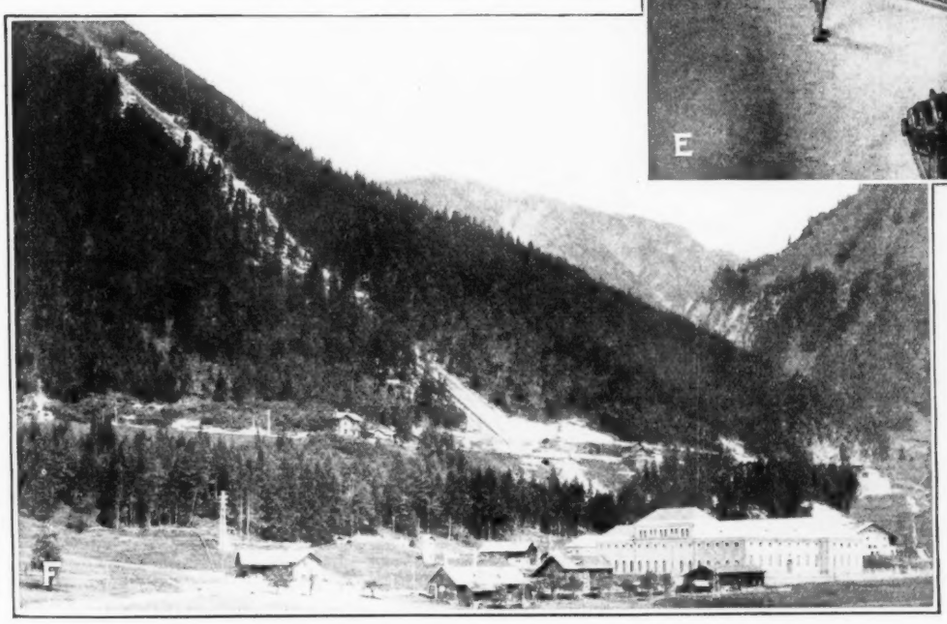




Hydro-Electric Plants

Bavaria, have a total capacity of 37,000 hp., and utilize a total head of 190 ft. A *is known as the Trostberg plant, rated at 2,650 hp.;* C, *the Tacherting plant, rated at 11,000 hp.;* D, *the Carowerk plant, rated at 23,100 hp. Plant* E *is at Inn Werk Bavaria, on the River Inn, and has 100,000 hp. installed in 15 units, 7 direct-current and 8 alternating-current generators.*

Photographs by Ewing Galloway, New York City



F *shows the Spullersee plant in Austria, at Danofer in the Alps. The water for this project comes from a lake 5,500 ft. above the plant.*

Combustion Control Formulas

III—Development of Heat Loss Equations

By E. A. UEHLING
M. E., Dr. of Engineering

THE pound carbon fuel unit, in addition to the great advantage of being equicalorific, lends itself to the development of simple formulas for calculating the heat losses and other factors that result from or enter into the operation of a steam boiler. The more alert engineer will want to know how the formulas were derived, and this knowledge will give him the necessary confidence in their practical usefulness.

It was demonstrated in the first article of this series, appearing in the Dec. 6 issue, that the theoretical minimum weight of air required to burn one pound of carbon is 11.6 lb. From the table of specific volume we find that one pound of air at 32 deg. F. has a volume of 12.388 cu.ft.; and therefore, since 11.6 lb. is the theoretical weight of air required, $11.6 \times 12.388 = 143.7$ cu.ft. of air required to burn one pound of carbon. In the burning of one pound of carbon with the theoretical weight of air, every molecule of oxygen in the air supplied unites with one atom of carbon and forms one molecule of CO_2, hence there will result as many molecules of CO_2 as there were molecules of oxygen consumed. According to Avogadro's law a given number of molecules of one gas occupies the same space as the same number of molecules of any other gas. Hence the volume of CO_2 produced is equal to the volume of oxygen consumed, when measured at the same temperature and pressure. Nitrogen is inactive and passes through the furnace unchanged. It is evident that in burning one pound of carbon, the volume of gas produced—that is, the products of combustion—will be equal to the volume of air supplied, namely, 143.7 cu.ft. at 32 deg. F.

> THE equations derived in this article are based on the pound carbon fuel unit which was shown in article II of this series to be nearly equicalorific for each type of fuel.

Now since air is composed of 21 per cent oxygen and 79 per cent nitrogen, and the volume of CO_2 produced equals the volume of oxygen consumed, it follows that the products of combustion will contain 21 per cent of CO_2. Thus, if we let the symbol CO_2 stand for the per cent of carbon dioxide, and O stand for the per cent of oxygen, we have

$$\frac{CO_2}{100} \times 143.7 = \frac{O}{100} \times 143.7 = \frac{21}{100} \times 143.7$$

Multiplying both sides of the equation by 100, we have

$$CO_2 \times 143.7 = 21 \times 143.7 \text{ and } CO_2 = \frac{21 \times 143.7}{143.7} \quad (a)$$

which in the simplest form states that the per cent of CO_2 equals 21 × 143.7 divided by the products of combustion when carbon is burned with the theoretical volume of air required for complete combustion. This holds true also when more than the theoretical volume of air is supplied. Then the products of combustion = 143.7 + excess air and equation *a* becomes

$$CO_2 = \frac{21 \times 143.7}{143.7 + \text{Excess air}} \quad (b)$$

Inverting both sides of this equation and multiplying by 143.7 we get

$$\frac{21}{CO_2} \times 143.7 = 143.7 + \text{excess air} = \text{total volume of air supplied} \quad (c)$$

Equation *c* signifies that the ratio of 21 to the per cent of CO_2 contained in the gas multiplied by the theoretical volume of air required to burn one pound of carbon equals the volume of gas produced.

The heat contained in the gas produced in burning one pound of carbon is obtained by multiplying the weight of gas by its specific heat, which is the heat required to raise one pound of the gas one degree. Since 143.7 cu.ft. of air weighs 11.6 lb. and $\frac{21 \times 143.7}{CO_2}$ = total volume of air supplied, we have $\frac{21 \times 11.6}{CO_2} = \frac{243.6}{CO_2}$ = weight of air supplied per pound of carbon burned. (*d*)

The weight of dry gas equals the weight of air supplied plus the weight of carbon burned, hence

$$1 + \frac{243.6}{CO_2} = \text{weight of gas produced per pound of carbon burned} \quad (e)$$

DENSITY AND SPECIFIC HEAT

Constituent	Cu.Ft. per Lb.	(W) Weight per Cu.Ft., Lb.	(S) Specific Heat	W × S = B.t.u. per Cu.Ft.
CO_2	8.152	0.12267	0.217	0.0266
CO	12.81	0.07807	0.2479	0.01935
Air	12.388	0.08073	0.2375	0.01917
N	12.77	0.07831	0.2438	0.01909
H_2O	19.922	0.0502	0.4805	0.02412

The volumes and weights are at a temperature of 32 deg. F.

The conventional way to calculate the heat contained in the gas is to determine the weight of each of the constituents per pound of fuel burned and multiply these weights by the respective specific heats of the constitu-

ents; the sum of the results will be the correct heat in B.t.u. per degree of temperature per pound of fuel burned. This method of arriving at the heat in the gas involves a half dozen or more long and tedious calculations. Practically the same results are obtained by using equation *e* and multiplying by the specific heat of the products of combustion which averages close to that of air itself, namely, 0.2375, and for brevity can be taken as 0.24; therefore

$$\left(1 + \frac{243.6}{CO_2}\right) \times 0.24 = 0.24 + \frac{58.46}{CO_2} = \text{B.t.u.}$$

contained in the gas resulting from the combustion of one pound of carbon per degree of temperature (*f*)

Now, if we let T = the temperature of the gas on leaving the boiler and t the temperature of the air, then Formula 1,

$\left(0.24 + \frac{58.46}{CO_2}\right) \times (T - t)$ = B.t.u. loss in the dry flue gas per pound of carbon burned.

So far we have assumed that the combustible in the fuel burned to be carbon only, but all natural fuels contain hydrogen and since the pound carbon fuel unit is practically equicalorific, it is most advantageous to base all heat-loss calculations on that unit. It is therefore necessary to demonstrate that Formula 1 holds good whether the combustible in the fuel consists of pure carbon or of carbon and hydrogen as all natural fuels do.

It was shown in Article I that 8 lb. of oxygen is required to burn one pound of hydrogen, forming 9 lb. of steam; also that the 8 lb. of oxygen is accompanied by 26.8 lb. of nitrogen. Hence 26.8 + 8 = 34.8 lb. of air is required to burn one pound of hydrogen. The water or steam produced in burning the hydrogen, along with the moisture and water of hydration contained in the coal, is condensed when the gas is sampled for analysis. Hence it does not enter into the composition of the dry gas and must be considered by itself. But the nitrogen (N_h) accompanying the oxygen required to burn the available hydrogen must be added to the products of combustion, hence equation *b* becomes

$$CO_2 = \frac{21 \times 143.7}{143.7 + \text{excess air} + N_h}$$

The only effect of the available hydrogen contained in the fuel is to increase the volume and hence the weight of the products of combustion per pound carbon unit in the same manner as does excess air. Hence the per cent of CO_2 decreases as the nitrogen, brought in by the air required to burn the hydrogen, increases. Therefore Formula 1 holds as true for fuel containing hydrogen as it does for fuel consisting of pure carbon. If the fuel contains available hydrogen (Ha) then equation *a* becomes

$$CO_2 = \frac{21 \times 143.7}{143.7 + N_h}$$

How much the nitrogen added to the dry gas affects the per cent of CO_2 is best shown by an example. The weight per cubic foot of nitrogen is 0.07831 (see table), hence for every pound of hydrogen burned $\frac{26.8}{0.07831}$ = 342 cu.ft. of nitrogen is added to the gas. One pound carbon unit of bituminous coal contains 0.054 lb. of available hydrogen, therefore $N_h = 0.054 \times 342 = 18.5$ cu.ft. Inserting the value of N_h in equation *a*, we have

$$CO_2 = \frac{21 \times 143.7}{143.7 + 18.47} = \frac{30.18}{162.17} = 18.6 \text{ per cent.}$$

It is quite immaterial whether the dry products of combustion are diluted by excess air or nitrogen, the per cent of CO_2 always equals twenty-one times the volume of air required for the complete burning of one pound of carbon divided by the volume of the dry products of combustion.

The heat carried off by the CO depends on the volume relation between CO and CO_2. The weight of carbon contained in a molecule of CO is the same as in CO_2 because each molecule contains one atom of carbon. Hence, if we denote the weight of carbon contained in the CO by Z, the weight contained in the CO_2 per unit of fuel burned will equal 1-Z, because the pound carbon fuel unit contains one pound of carbon. It follows from Avogadro's law that the weight of carbon carried by each of these two gases is proportional to their volumes. From these considerations the following relation may be written:

$$\frac{CO}{CO_2} = \frac{Z}{1 - Z} \text{ and } Z = \frac{CO}{CO + CO_2}$$

= pounds of carbon burned to CO per pound carbon unit. The heat generated in burning one pound of carbon from CO to CO_2 is 10,160 B.t.u., therefore

$$10{,}160 \times \frac{CO}{CO + CO_2} = \text{B.t.u. carried to waste per unit of fuel burned} \quad (2)$$

Formula 1: $\left(0.24 + \frac{58.46}{CO_2}\right) \times (T - t) =$ B.t.u. of sensible heat in dry gas per pound carbon unit.

Formula 2: $10{,}160 \times \frac{CO}{CO + CO_2} =$ B.t.u. heat loss per pound carbon heat unit due to incomplete combustion.

Formula 3: $H_1 [(10{,}640 - 9t + 4.3 \times (T - 212)] =$ B.t.u. heat loss due to hydrogen in the fuel per pound carbon unit.

Formula 4: $Av \times \left(\frac{117}{CO_2}\right) \times (T - t) =$ B.t.u. heat loss due to humidity in the air per pound carbon unit.

Formula 5: $\sqrt{Bd} \times CO_2 =$ index of the rate of combustion.

Formula 6: $\sqrt{Bd} =$ index of the normal exit gas temperature.

Heat Carried Off by Moisture in the Gas

Formulas 1 and 2 cover the heat contained in the dry gas; the former represents sensible heat and the latter potential heat, that is, the heat contained in the fuel but not liberated because of incomplete combustion. There is still to be considered the heat carried to waste by the water vapor in the gas. This comes from three dis-

tinct sources: *a*, water vapor in the air; *b*, moisture in the fuel; and *c*, the burning of hydrogen contained in the fuel. The amount of water vapor due to *a* and *b* is quite variable, but that due to *c* is practically constant because the weight of hydrogen (H_t) per pound carbon unit does not vary greatly in each class of fuel.

The heat contained in the wet gas comprises, *a*, the heat required to raise the water from atmospheric temperature *t* to 212 deg.; *b*, the heat of evaporation; and *c*, the heat required to raise the steam produced from 212 to the temperature *T* of the gas leaving the boiler. The heat contained in one pound of water vapor is therefore made up as follows:

a = B.t.u. required to raise one pound of water from *t* to 212 degrees,

b = 970.2 B.t.u. required to evaporate one pound of water,

c = $(T - 212) \times$ specific heat of steam equals the B.t.u. required to raise the temperature of one pound of steam from 212 degrees to *T* degrees.

If H_t equals the weight of hydrogen in one unit of fuel, the weight of wet gas per unit of fuel burned will be $9H_t$ lb., and if it is assumed that the fuel is dry, we have $9T_t \times [212 - t + 970.2 + (T - 212) \times S] =$ B.t.u. carried off by the water vapor per unit of fuel burned due to hydrogen in the fuel. Since *a* and *b* are independent of the temperature *T* and substituting the specific heat of steam $S = 0.48$, Formula 3 may be written $H_t [(10{,}640 - 9t) + 4.3 \times (T - 212)] =$ B.t.u. in the water vapor per pound carbon unit of fuel burned. The loss due to moisture in the fuel is taken care of by adding the weight of hydrogen it contains, which is one-ninth of its weight per pound carbon unit to the H_t in the fuel.

Heat Carried to Waste by the Humidity in the Air

The water vapor contained in the air exerts a chilling effect on the fire. If *Av* equals the weight of water vapor per pound of air supplied for combustion per pound carbon unit of fuel, then $Av \times S \times$ weight of air supplied per unit of fuel $\times (T - t) =$ B.t.u. carried to waste due to water vapor in the air supplied. The weight of air supplied $= \frac{243.6}{CO_2}$ and the specific heat of steam is 0.48. Hence $Av \times 0.48 \times \frac{243.6}{CO_2} \times (T - t) =$ B.t.u. loss. Multiplying through by 0.48, we have Formula 4:

$$Av \times \frac{117}{CO_2} \times (T - t) = \text{B.t.u. loss per pound carbon unit of fuel burned due to water vapor in the air.}$$

These four simple formulas account for all the heat carried to waste up the chimney, and if the per cent of CO_2 and CO and *T* are known, the losses can be readily calculated. The per cent of CO_2 and CO depend on the condition of the fire bed and the weight of air supplied per unit of fuel burned. The exit temperature is dependent on many factors, the most important of which are the per cent of excess air, and the rate of combustion, both of which affect the rate of gas flow.

The rate at which gas flows through any given conduit varies with the square root of the head. The boiler draft (*Bd*)—that is, the difference in draft between the furnace and the damper—is the head which causes the gas to flow through the boiler. The $\sqrt{Bd}$ is therefore a measure of the rate of gas flow. The volume of gas that will flow through the boiler for a given value of $\sqrt{Bd}$ will depend on the cross-sectional area and contour of the gas path, its length, and the number of turns and other obstructions interposed to the gas flow. All these conditions are fixed by the design and construction of the boiler and setting and are therefore constant in any given boiler and cannot be changed by the operating personnel. Since the $\sqrt{Bd}$ is a measure of the velocity at which the gas flows through the boiler, it is also an index of the time the gas can remain in contact with the heating surface and hence of the normal exit temperature.

Index to the Rate of Combustion

In normal boiler operation practically all the carbon contained in the fuel burned is contained in the gas in the form of CO_2. Now since $\sqrt{Bd}$ is the index of the rate at which the gas flows through the boiler and the per cent of CO_2 is the index of the amount of carbon it carries from the furnace to the chimney, it follows that $\sqrt{Bd} \times CO_2$ is an index to the rate of combustion.

If the boilers are equipped with the instruments that record the CO_2, CO, *T* and *Bd*, the operating engineer will have all the data required to exercise complete economic control over the operation of his boilers. The four heat-loss formulas will enable him to calculate all the heat losses up the chimney and the $\sqrt{Bd}$ will prove useful in controlling the temperature of the flue gas and the rate of combustion.

Friction of Water in Elbows

IT IS the practice of some engineers to prohibit the use of 90-deg. elbows in the pipe lines of heating systems and require, instead, two 45-deg. elbows and one nipple. This regulation is evidently based on the assumption that the friction in one 90-deg. elbow is in all cases higher than in two 45-deg. elbows and one nipple.

Questioning this practice, tests have been made at the University of Texas to determine the friction of water not only in standard 90-deg. elbows, but also in 90-deg. long radius elbows and in 45-deg. elbows. The results of these tests are reported by F. E. Giesecke, C. P. Reming and J. W. Knudson, Jr., in the University of Texas bulletin No. 2712, March 22, 1927.

Comparing a short-radius 90-deg. elbow with a long-radius 90-deg. elbow, the friction in a long-radius elbow is about 63 per cent of that in a short-radius elbow. The friction in a 45-deg. elbow is about 49 per cent of that in a short-radius 90-deg. elbow for a velocity of 3 ft. per sec. and a 3-in. pipe. These percentages are reduced slightly as the velocity is increased and increased as the diameter is increased.

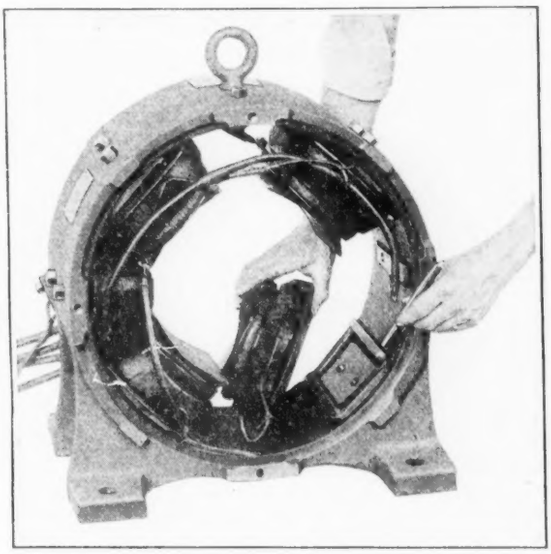
For elbows smaller than 3-in. the friction in two 45-deg. elbows and one nipple is greater than that in one short-radius elbow. For larger elbows it is less.

Comparing a long-radius 90-deg. elbow with a 45-deg. elbow, the friction in a 45-deg. elbow is about 78 per cent of that in a long radius 90 deg. elbow for a velocity of 3 ft. per sec. and a 3-in. elbow. This percentage is practically independent of the velocity and increases as the pipe diameter is increased.

ELECTRICAL *Operation and Maintenance*

Locating and Repairing

Open-Circuits in Direct-Current Motor Field Coils



By C. O. MILLS

FAULTS in the field coils of direct-current motors may be divided into three classes—open circuit, short circuit and grounds. The effects that these will have on the machine's operation will depend on the type of machine and the conditions under which the defect develops. Under certain conditions some of the defects may exist for months or even years without being detected. Generally, however, they cause the machine to operate so unsatisfactorily that it must be shut down or the protective device opens and automatically disconnects the motor from the circuit.

In this article open circuits will be considered and how to locate and repair them. The current taken by a motor is limited largely by the counter-electromotive force generated in its armature. For example, the resistance of the armature circuit may be 0.5 ohm., which, if connected directly to a 220-volt circuit, would take $220 \div 0.5 = 440$ amperes. Such an armature would generate in its winding at full load a counter-electromotive force of about 210 volts. As this voltage is in opposition to the line volts $220 - 210 = 10$ volts only that is available to cause the current to flow through the armature's winding. Ten volts applied to a resistance of one-half ohm will produce a current of $10 \div 0.5 = 20$ amperes.

Such a motor would be fused for about 25 or 30 amperes. If the field circuit opened, the counter-electromotive force in the armature would decrease rapidly and the current would increase to a point where the fuses would blow. Weakening the field on the motor also tends to cause the armature to increase in speed. If the motor happened to be lightly loaded and was also heavily overfused, the motor might race if the field circuit opened.

If the motor is connected to a manual-type starting box, as in Fig. 1, and the holding coil is in series with the field coils as shown, opening of the field-coil circuit will also open the holding-coil circuit and release the starting-box arm. In many cases the starting-box arm will return to the off position so quickly that the fuses will not blow. In other cases the time lag of the starting-box arm is sufficient to let the armature current reach a value where the protective device will open.

Where the coil of the starting box is connected across the line, as in Fig 2, opening the field-coil circuit will not release the starting-box arm, and the only protection the motor has is the fuses or circuit breaker. If of the proper rating, these will open before the motor is injured.

What has been said about a motor connected to the starting box, Fig. 2, also applies to many of the automatic starters. On some types of controllers a field relay is used, which has its coil connected in the field circuit, and unless this circuit is alive the controller cannot function to start the motor. Should the motor be in operation when the field circuit opens, the relay will open and interrupt the power circuit to the motor.

When the field circuit opens on a large shunt machine, unless it is quickly disconnected from the line, it may flash over at the commutator. This is practically the equivalent to a dead short-circuit across the line, which will open the protective device. On flashover the current may attain a value that will burn the commutator and the brush rigging. This is particularly true on machines operating at 500 volts and higher.

A shunt motor without load and with the field circuit open, will do one of three things if an attempt is made to start it: If the brushes are set on the neutral, the armature will not start; when the brushes are set ahead of the neutral, the armature will start in the same direction that it has been running, but will race when the starting resistance is only partly cut out of circuit; if the brushes are set back of the neutral, the armature will start in a direction opposite to that for normal operation and will race as previously mentioned.

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When the motor is loaded, it will not start when any of the foregoing conditions exist. If the starting resistance is allowed to stay in circuit for a short period, it will become very hot. Another indication of an open field circuit is the heavy arc that will develop when the starting-box arm is allowed to drop to the off position.

A compound motor, Fig. 3, has a series winding which will influence the action of the machine if the shunt-winding circuit opens. The series winding on compound motors varies widely, depending on what its purpose is. On some machines a small number of ampere turns only are put in the series winding for stabilizing the operation of the machine. On such machines, if the shunt winding were to open, the action of the machine would be about the same as with the straight shunt motor. The inductance of the series winding will prevent the current in the armature from increasing as rapidly as in the simple shunt motor, therefore the compound machine is not as likely to flash over as the shunt motor.

Where compound motors are designed for starting under heavy load, the series winding is designed to produce a large part of the ampere turns. On such motors, opening the shunt field circuit may not seriously interfere with the motor's operation, particularly if it is operating with about 75 per cent rated load. If there is no load on the motor, it will race. Unlike the shunt motor, it will start under almost any condition of load.

The writer recalls finding compound motors driving pumps with the shunt-field circuit open. These motors operated at a higher speed and temperature than normal, and if they had been allowed to operate under this condition a sufficient length of time, they would probably have burned out their windings. In another case an elevator motor was found to be operating with the shunt-field winding open-circuited. This machine was hand-rope controlled and the operator could manipulate the controller so as not to cut out the series winding of the motor and thus prevented blowing the fuses.

When a motor develops any of the symptoms of an open field circuit, a simple test can be easily made by opening the armature circuit at the starter, as in Fig. 5. Then close the switch and place the arm of the starter on the first contact. After a few seconds let the arm drop to the off position. If a severe spark occurs, it indicates that the field circuit is closed. The absence of the spark shows that it is open. This statement is based on the assumption that a previous attempt has been made to start the motor and it failed to start, and a severe spark was obtained when the contact on the starter was broken. Absence of the spark, when attempting to start the motor, would indicate that power was not getting to the motor and that probably the fuses were blown, or the circuit breaker was open.

On manual-type starters, where the holding coil is in circuit with the shunt-field winding, a common place for an open-circuit is where the holding coil connects to its terminal posts. Something hits the leads of the coil and breaks them. Anywhere a wire connects to a binding post is a potential source of trouble. When the insulation is cleaned from the wire to make the connection, it may be nicked and then, after connection is made, vibration or other causes may break the wire.

After it has been ascertained that the field circuit is open, all the connections in the circuit should be ex-

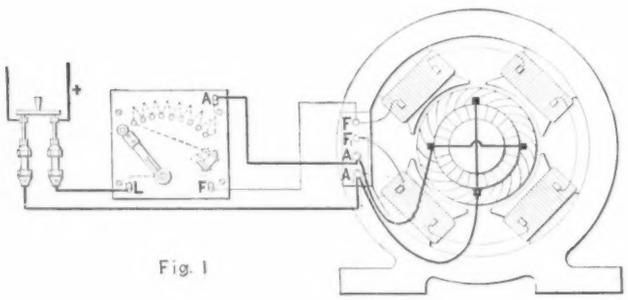

Fig. 1

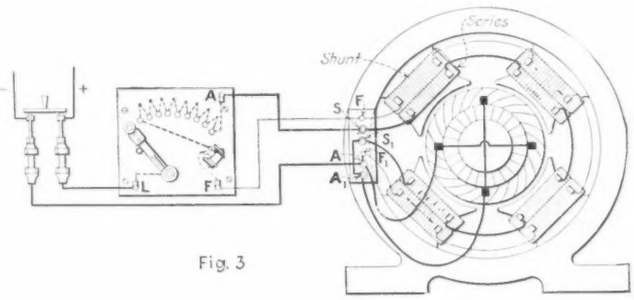

Fig. 3

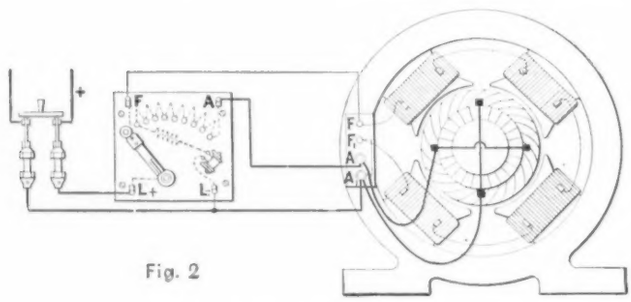

Fig. 2

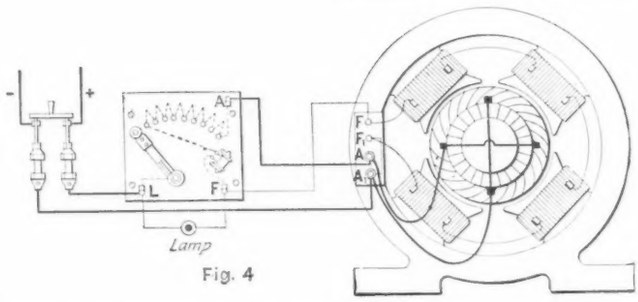

Fig. 4

Figs. 1 to 4—Direct-current motors connected to a manual-type starting box

Fig. 1—Shunt motor with field coils connected in series with no-voltage release coil on the starter. Fig. 2—No-voltage release coil on the starter connected across the line. Fig. 3—Compound motor connected to starting box. Fig. 4—Lamp connected to starting box to test for an open in this part of the field circuit. The lamp should light if the field circuit is complete.

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amined to see if any are the cause of the fault. When this has been done and the defect has not been found, tests should be made.

A test to determine if the trouble is in the starting box can be made by connecting a lamp from the *L* to the *F* terminals, as in Fig. 4, and then closing the switch. If the open circuit is in the starting box, the lamp will light. Should the lamp not light, then the defect is outside the starter.

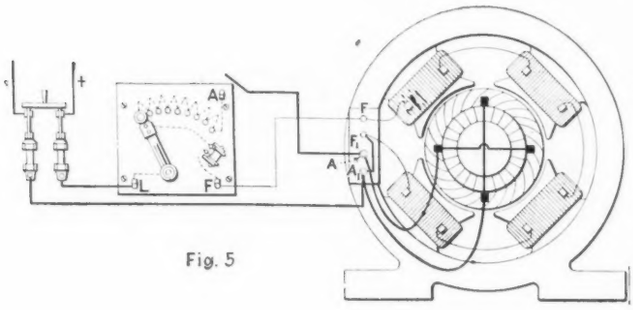
Assume that such a test had been made and the lamp did not light. The lamp should then be connected from the field to the line connection on the motor, as in Fig. 6, with the starting-box arm on the first point and the switch closed. The lamp is now in parallel with the field coils, and it should light if the field circuit is complete to the motor. If the lamp does not light, it indicates that the field wire between the starting box and the motor is open. If the lamp lights, it indicates that the fault is in the field coils. A test for this fault can be made by connecting a piece of wire across the terminals of one field coil at a time, as indicated by the dotted line on coil *A* in Fig. 7. Then close the switch and place the starting-box arm on the first point. When the defective coil has been bridged, a spark will be obtained when the starting-box arm breaks contact.

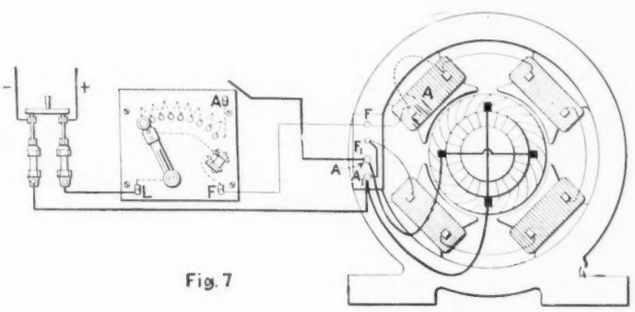
Another method of testing for the faulty coil is, after the lamp lights when connected as in Fig. 6, leave one lamp lead connected to the field terminal and with the other lead connect in between the field coils as at *A*, *B*, *C* and *D*, Fig. 8. When these connections are made, the switch should be closed and the starting-box arm held on the first contact. If the lamp were to light when connected to terminal *A* and did not when connected to *B*, it would show that coil *B'* was open-circuited.

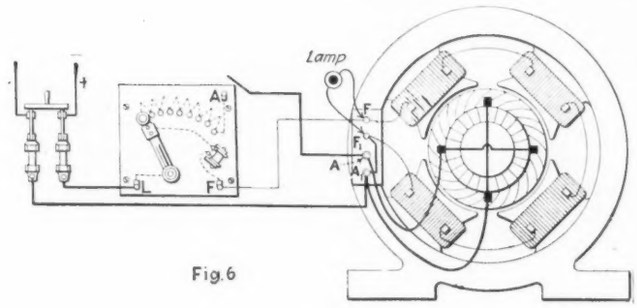
When the faulty coil has been located, it may be possible to repair it without removing it from the machine, particularly if the machine is of medium or large size. First the terminals of the coil should be carefully examined after disconnecting from the other coils. Then it should be tested through with a test lamp to make sure that the fault is in the coil. If the fault is found to exist still the insulation may be removed from the coil if it is decided to try and repair it in the machine, and the surface turns examined closely for signs of burned insulation or a broken wire. In some cases when the coil opens, it draws an arc where the break occurs, which will leave a burned spot in the insulation. Where the coil connects to the terminals, is the most likely place to find the defect. If it cannot be found here or on the surface of the coil, the coil should be tested through again, to ascertain that the fault is still in the coil.

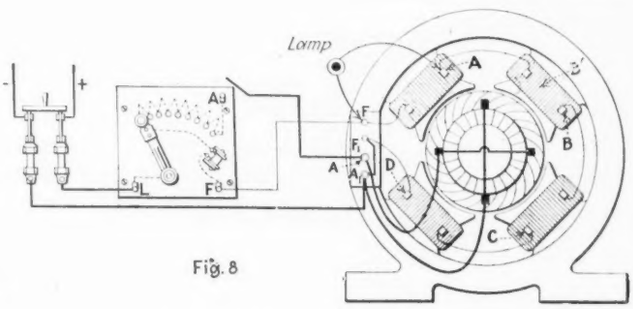
If the coil has to be removed to make the repair, it may be found possible to remove the coil without taking out the armature. This can be done on some machines by removing the bolts that hold the polepiece to the frame and then sliding the coil out toward the back end of the armature. Where the polepiece is on the top side of the armature, place a piece of heavy cardboard between the armature and the pole face so that the pole can be easily slid out of place and will not injure the armature.

If the fault cannot be found on the outside of the coil, it will be necessary to unwind the coil until the defect is found, and repair it or completely rewind the coil with new wire.









Figs. 5 to 8—Connections for locating an open in the field circuit

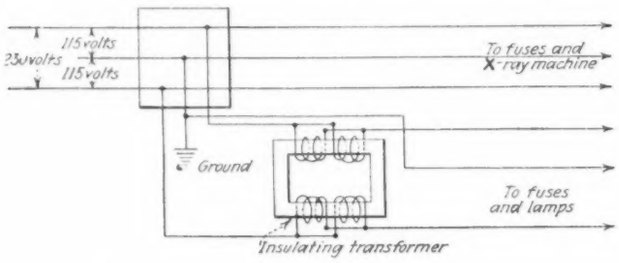
Fig. 5—Testing the field circuit. Fig. 6—Testing the field wiring between the starter and the motor. Fig. 7—Testing field coils by bridging them. Fig. 8—Testing for open circuits in field coils with a lamp. When defective coil is bridged, the lamp will light.

ELECTRICAL *Operation and Maintenance*

High Frequency Caused Burn-Outs

OCCASIONALLY, a voltage complaint offers a good opportunity for the engineer in charge to try much of his training. I was called upon some time ago to solve a case of frequent lamp burn-outs which finally terminated in an unusual experience. The lamps on a circuit were reported to be burning out frequently. Indicating meter readings showed the voltage to be 112, while the lamp rating was 110 volts. To supplement the indicating voltmeter readings, graphic voltmeters were installed for two days and nights. The results of this test substantiated the indicating readings by showing the voltage to vary between 111 and 114 volts. These results were not alarming as the life of the 110-volt lamps is only reduced about 20 per cent, and it was felt the increased illumination would justify the decreased life. The complaint was closed on this basis.

Only a short time elapsed before the complaint was repeated. The same investigation was made and the



Connections for insulating transformer

same results obtained. However, while inspecting one of the lamp filaments it was observed that it seemed to be somewhat crystallized. But this was not thought important and the complaint was again closed out. Within a few weeks the complaint was again made.

It was then decided that something unusual must exist, something that could not be located with a voltmeter. Remembering the appearance of the lamp filaments on a previous visit, a thorough investigation of the load on the line was made, which resulted in locating a small X-ray machine. This machine operated for short periods only but at a high frequency. It was fed from the same service cable that fed the light load, which was complained of. It was then felt that the high frequency kicked back into the circuit, each kick tending to shatter the lamp filaments slightly and accumulating until the filament was finally broken.

Working upon this theory, an insulating transformer was built, using an old transformer core on which four coils were wound, each having ten turns of No. 12 wire and installed as shown in the figure. This apparently solved the trouble, for after the installation of the transformer, normal life was obtained from the lamps.

Others may run across such a complaint and if the lamp filament appears to be crystallized it may be caused by a high frequency being superimposed on the line.

Flushing, N. Y. MAURICE D. SMITH.

How It Can Be Done

IN REPLY to the question in the Oct. 11 issue on "How Would You Do It?," practically the same conditions exist in the plant of which I have charge as described in the article, except that we have two-phase instead of three. We have lost air a number of times, but have had no trouble in starting since our first experience, which was less than a week after the Diesel was installed (1923). Then we used up some days in trying to "start the unit by using the generator as a synchronous motor and taking power from the steam engine unit." Failing in this manner to accomplish the desired results, I doubt that it can be done with the generator "as a synchronous motor," unless there is an exciter on the steam unit or one independent of either unit, large enough to excite the fields of both generators. Success crowned my efforts, however, by starting the generator and running it as an induction motor. For the benefit of those interested, I will here describe the process by which results were obtained, designating it as Rule 1, also the shorter cut that was doped out later (and which has been used successfully for some time) I will designate as Rule 2.

Rule 1.—Open the field switch, cutting the exciter off that unit. Put a jumper across the field-end, short-circuiting the field. Keep busbars clear. Close generator switches. Turn the resistance all out of the rheostat in the exciter field. Hook the exhaust valve of the oil engine down. Close the stop valves in the air line to the fuel oil valves. Start the steam engine. Watch the ammeters on both units, until they reach 20 per cent above rating per phase, and hold them at this point by regulating the engine's speed. Now have some one start the Diesel by barring it over. This will pump the air up and fill the injection bottle and starting bottles, but if one prefers to fill the starting bottles and start with air it is best to take out the exhaust valves first.

Rule 2.—Start by having the injection bottle well pumped up, engine primed and everything ready as for starting with air. Be particular to have oil flowing from the fuel valve. Open the air valve to fuel oil valve to one cylinder first. Unhook the exhaust valve, and the engine should begin to fire. Repeat this process with each cylinder until they all fire. As soon as the engine is able to take care of itself, open the main switch in the steam unit, being particular to keep the speed of the steam engine down as low as possible after getting the required number of amperes, never letting the generator of the oil engine become overheated.

Our Diesel requires from 800 to 900 lb. air pressure to start it. When there is 500 or 600 lb. pressure left in the starting bottles, get the engine into starting position, the same as for starting with air. Go through the same operation as before, in starting the steam engine. Bring up to the desired amperes, then, instead of barring the engine over, open the starting air valve.

We have never failed to start our Diesel under the rules given in the foregoing and we have applied them several times. T. M. EDWARDS.

East Hampton, N. Y.

INTERNAL COMBUSTION ENGINES

Where is the Power In a Double-Acting Diesel?

By Donald McFee

WHY all Diesel engines should not be double acting was a problem that had long worried Jim Roberts, the bright young assistant engineer of the Teneha light plant. Egan, the chief, was of the type that encouraged his men to think, and the double-acting

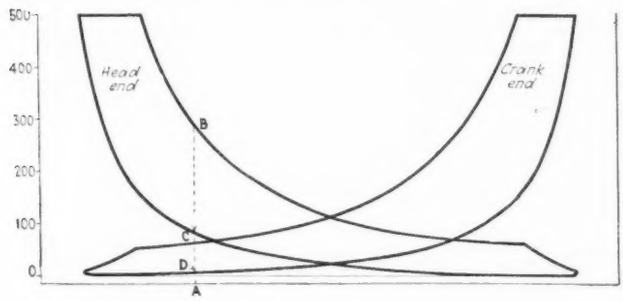


Fig. 1—The double-acting Diesel diagrams Egan drew

idea was born as a result of one of the many talks the men engaged in.

Roberts had just started the 2,000-hp. single-acting unit that had been installed a week before and stood back to admire the smoothness of the action.

"She runs as sweetly as a race horse," exclaimed Egan as he joined Roberts.

"Seems she is carrying too much weight to be in the real race horse class," Roberts returned. "I never could understand why, as long as they took the crank, piston and flywheel from Jimmie Watt's steam engine, that they didn't take the hair along with the hide and adopt the double-acting cylinder."

"That's a long sentence, Roberts," smiled the chief. "I wonder if its grammar is any better than its logic."

"What's the matter with the logic part?" his assistant wanted to know.

"Why do you keep talking about double-acting engines? What is there about the animal that appeals so?"

"Why you are almost getting something for nothing," declared Roberts. "If you make the cylinder a little longer, close the bottom end and add a few riggings, you'll get twice the power that engine there can deliver."

"I'll not deny," Egan responded teasingly, "that ultimately you will get *almost* twice the power. But confidently, just how much of this power you are going to get, will be delivered from the top end and how much from the bottom?"

"You've got No. 2 on the line," he continued, "so you'll have time to think for a few minutes. Let us take a concrete case. Suppose you had a 26x48-in. double-acting two-stroke-cycle Diesel running at 100 r.p.m. To start you out, we will agree that this cylinder will deliver 800 b.hp. I'll even tell you that the piston rod is 8 in. in diameter and the mechanical efficiency is 75 per cent. Now during one complete revolution what power is developed in the top end and what in the bottom end?"

Turning to the desk, Roberts scribbled a few seconds and then announced his result.

"I figure," he announced, "that the engine develops a total of 800 divided by 0.75, or 1,066 i.hp. Now if the rod has a diameter of 8 in. its area is 50+ sq.in. The area of the piston is 531 sq.in. Deducting from this the 50 sq.in. of the rod gives the bottom end 481 sq.in. and the top 531, or a total of 1,012 sq.in. So," Roberts concluded, "we get 1,066 hp. for 1,012 sq. in. of piston area, or 1.05 hp. per sq.in. If this is true, the top end develops 531 × 1.05, or 557+ hp., and the bottom end 505.

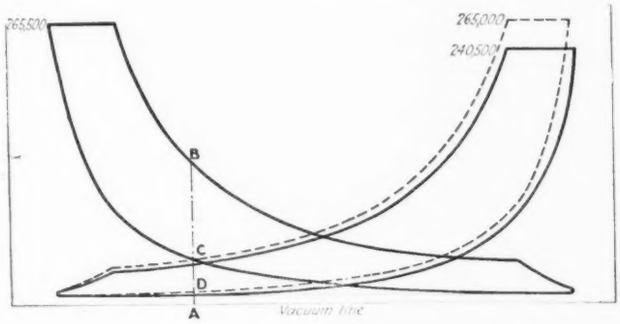


Fig. 2—He allows for the piston rod

The answers don't quite jibe with the 1,066, but I dropped the fractions as I worked it out."

"Roberts, my boy," laughed Egan, "You are becoming a wizard as a mathematician, and even though your answer is correct, it's wrong."

"I'll eat my hat if it's wrong. Show me where I am wrong." The assistant, being from Missouri, insisted on being shown. So strong was his state affection that

INTERNAL COMBUSTION *Engines*

he at times even refused to believe himself, especially when recounting some of his tales of life in Old Mexico.

"Now, my boy," Egan returned conciliatingly, for he knew Roberts was easily riled, "I don't deny that your total horsepower is correct, but your division of the work between the two ends is as one-sided as that of the big

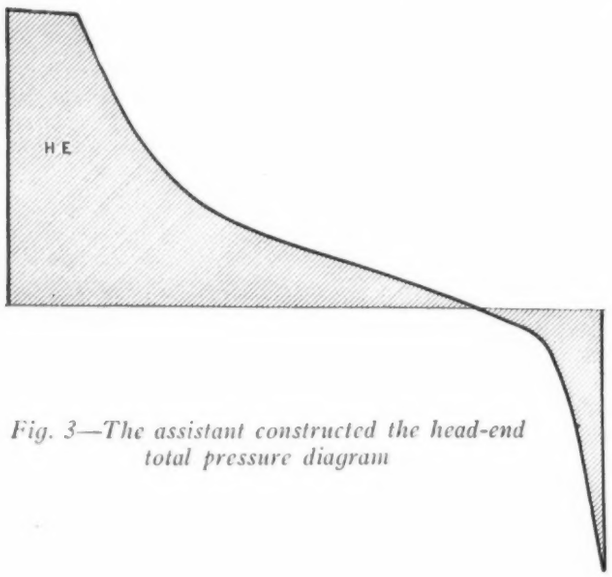


Fig. 3—The assistant constructed the head-end total pressure diagram

fellow in the movies who acts in an advisory capacity to the little fellow moving the piano.

"Suppose I answer your question by first asking another," he continued. "I will sketch two indicator diagrams, which we will make Fig. 1, and we will assume that they were taken from this double-acting engine. Now tell me, Roberts, what is the pressure exerted on the piston on the down stroke at the point *A* in the stroke proportional to?"

"You can't catch me on that," declared the assistant. "I state that it's proportional to the distance *BC*."

"As usual," Egan remarked dryly, "you are wrong.

"Now, my boy," he continued, "listen while an old timer reveals some confidential information. When the piston is moving downward on the power stroke, it is opposed by the compression not in the top end but in the bottom end. So its net pressure is not proportional to *BC*, but to *BA*, minus the small distance *AD* the crank-end compression is above the atmospheric line."

"That's clear," conceded Roberts. "But it makes mighty little difference in the answer."

"That is a hasty conclusion not worthy of your mentality," Egan returned with a grin. "Remember that while we talk of cylinder pressures in terms of pounds per square inch, it's the total pressure in the piston that determines the power developed. So let's pretend the height of the diagram is scaled to total cylinder pressures. Since the piston has a diameter of 26 in., its top area is 531 sq.in., and with a maximum pressure of 500 lb. per sq.in. the total pressure on the piston top is 265,500 lb., and we can simply multiply our indicator diagram scale by 531 to make a scale for the entire top end in terms of total cylinder pressure. Now as to the crank or lower end——"

"What's the matter with using the same scale," broke in the assistant. "The cylinder is the same diameter all through."

"A while ago you mentioned the piston rod, so I supposed you intended to keep it in the engine."

"I declare I forgot all about that," Roberts apologized. "But how are we going to fix up the diagram if we allow for the rod?"

"Well, by your calculations a while ago you found the rod had a sectional area of 50 sq.in. If we deduct this from 531, we have 481 sq.in. on the piston bottom. A maximum pressure of 500 lb. would then give a total of 240,500 lb.

"Our crank end diagram," continued Egan, "is then too high if we use the same scale as for the head end. So we will remake it by locating the curves at the proper places."

At this point the chief busied himself in redrawing the two diagrams, producing for Roberts' inspection the diagram labeled Fig. 2, in which he showed the old crank-

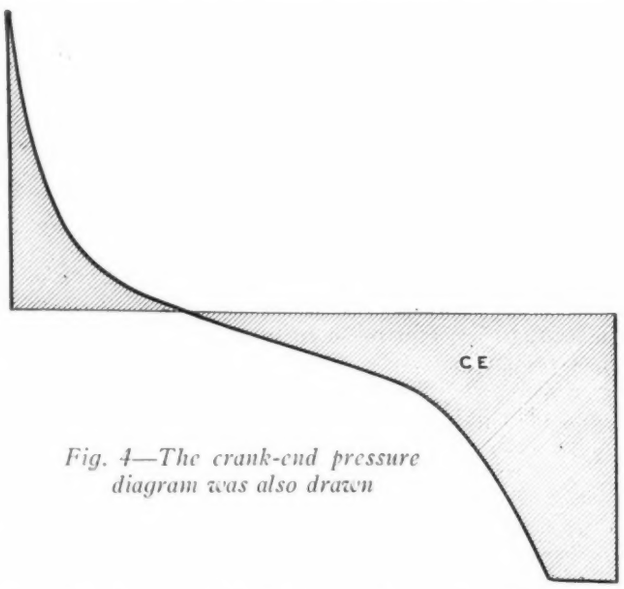


Fig. 4—The crank-end pressure diagram was also drawn

end diagram in broken lines and the corrected one along with the head-end diagram in full lines.

"Now, my boy, remember that at any point *A* the total pressure on the piston top is proportional to the distance *BA* and this is opposed by the compression pressure in the crank end as measured by *DA*. The difference *BD* represents the pressure forcing the piston downward. On the upstroke the same process must be followed."

Egan continued: "You see that the head end or crank end diagram, when taken alone, does not give the net pressure on the piston during any particular stroke. What we should do is to build up two new diagrams, showing the net pressures on each stroke. This is done by subtracting the compression pressure in one end from the expansion pressure in the other. That is a job I'll leave you do while I work out our daily cost sheet."

INTERNAL COMBUSTION *Engines*

Roberts tacked the diagrams of Fig. 2 to his drawing board and got busy with his compass and T-square. In a short time he produced Figs. 3 and 4 for Egan's inspection.

"Now, Chief, I think I see through it, for this is somewhat like a net force diagram you one time drew for us boys. See if I'm right.

"I measured the distance between the head-end expansion and the crank-end compression line at various points on the stroke and laid these off above the base line. I also did the same for the crank end, but put the curve of pressures below the zero line. This drawing, Fig. 4, is the result, while Fig. 3 is for the head end. Then I subtracted the negative work on the head end from positive work diagram. I also did the same for the crank end and by combining drew Fig. 5."

Egan was visibly proud of his assistant's work, for it proved the boy was thinking, so he did not hesitate to voice his praise.

"Roberts, that is a fine piece of work and you can see that the head end is doing considerably more than the crank end. But have you considered the effect of gravity?"

"That's over my head," Roberts acknowledged, who failed to see or overlooked the fact that on the down stroke the weight of the piston, piston rod and connecting rod was helping to turn the crank while on the up stroke those parts had to be lifted against the gravity pull.

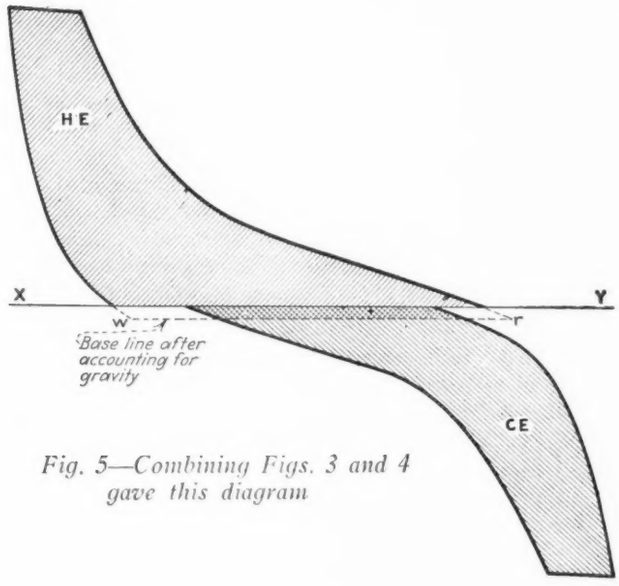


Fig. 5—Combining Figs. 3 and 4 gave this diagram

But as soon as Egan had pointed out this action, Roberts was quick to accept it, only he did not quite know how to make it show on the diagram.

So Egan tried to help by asking the question, "These parts exert a constant gravity effect throughout the stroke, don't they? If so, couldn't you make a new base line such that the head-end diagram is of a greater depth and the crank-end diagram of less depth?"

"That would do," agreed the assistant, "but I don't see where the line is to be placed."

"Suppose we say the parts weighed 10,000 lb. If we lay off a line at the 10,000-lb. mark below the base line we have increased the head end diagram by 10,000 lb., and by subtracting 10,000 lb. from the crank-end diagram we can correct this diagram by drawing the new base in the shape of a broken line."

Roberts did as suggested on Fig. 5, and as he compared this with the two diagrams in Fig. 1, he could see that

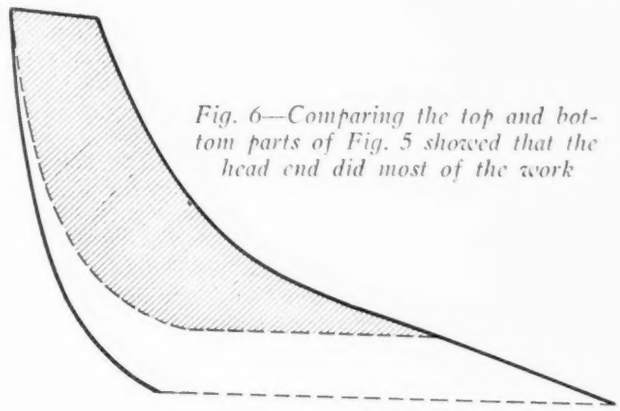


Fig. 6—Comparing the top and bottom parts of Fig. 5 showed that the head end did most of the work

the outputs of the two ends were by no means equal. To satisfy himself he cut out the crank-end diagram and by placing it over the head-end diagram, made the difference more noticeable.

Egan left Roberts to digest the problem for some time and concluded the morning's discussion by pointing out that while a double-acting engine was double-acting, the powers developed in the two ends were by no means equal. "But," he reminded Roberts, "when you have two such cylinders, the two pistons balance and the difference in diagram areas is due to the presence of the rod only."

Thoughts on the Installation of Producer-Gas Engines

By H. Weiland Los

ALTHOUGH many producer-gas engines have been supplanted by oil engines or electric motors, a number of these engines are still rendering reliable and economical service. On the other hand, many failures of suction-gas engines are on record, but have not operators of oil engines and electrical machinery experienced all kinds of trouble? It is beyond dispute that local conditions have much to do with unsatisfactory service of internal-combustion engines, especially when they are installed in an out-of-the-way place or the operating force is inexperienced.

An important problem involved in the operation of a producer-gas engine is embodied in the cooling of the gas during its passage through the scrubber and the engine cylinders. If the charge is not sufficiently cooled down by means of cold water before entering the combustion chamber, the temperature will be relatively high and the specific weight correspondingly low, so that the capacity

of the engine per pound of gas will be more or less reduced. Moreover, part of the gas will condense in the piping system instead of in the scrubbers, and during starting the moisture will be drawn into the combustion chambers, thereby fouling the igniters.

In case warm cooling water flows into the breech end water passages and cylinder water jackets, then matters grow worse. The tar on the inlet-valve cages will cause the valves to stick and leak; if not, heavy preignitions will be set up.

When the cooling water supply is limited, the heavy-oil engine is generally preferable to the gas engine unless the existence of fuel in the shape of waste material makes the installation of recooling equipment warranted. However, it is not generally known that the water consumption of a producer-gas plant can be substantially decreased by turning the waste cooling water of the engine cylinders into the washing and filtering apparatus of the gas plant. If required, cooling the waste water of the engine can be easily done, for instance, by atomizing the tepid water and exposing it to the surrounding air.

Installing an Engine in Cramped Quarters

Sometimes it is necessary to install an engine in cramped quarters, and it is here that operating experience counts. By grouping the engine and auxiliaries properly, all the parts that require adjustment are within easy reach.

The exhaust pipe should not be embedded in concrete or brickwork. In one particular instance a 4-in. exhaust bend was entirely enclosed by brickwork, so that the bend attained an abnormally high temperature. After three years the engine's capacity decreased rapidly, until it was hardly possible to carry 5 per cent of the normal rating. Finally, somebody suggested removing the brickwork, and it was found that the passage through the exhaust bend was considerably restricted, owing to collapse of the horizontal part of the bend. After the defective part has been replaced, everything was found to be normal again.

Furthermore, one must take into account that a gas engine is a poor pump, so that it is necessary that the suction line offers a minimum of resistance.

Making Good Gas

If the producer is not well designed, the CO_2 is not effectively reduced to CO, the height of the combustion zone is abnormally increased and part of the gas produced ignites on top of the fuel bed, causing unsatisfactory operation of the engine. The flame may be temporarily quenched by feeding more coal, but finally the whole mass of fuel is set on fire and the production of gas is interrupted unless it is possible to remove a part of the fire during operation of the engine.

The next time that the plant is to be started, a large quantity of unconsumed coal must be removed in order to make starting possible. The unconsumed coal has been incandescent and is inferior to the green coal. When the producer attendant endeavors to fire the unconsumed coal again, matters are growing worse. Still more coal is needed and must be afterward removed. In such a case a radical cure is recommended.

Normal gas production should be possible with a shallow fire in the producer. A minimum loss of coal is an indication that the plant is in good condition and a criterion of efficient gas production.

What Do You Know?

By L. H. Morrison

The answers are on page 1028

IN DISCUSSING the qualifications of an engineer in his absence, a fellow engineer remarked, "He isn't one of these fellows who are lazy and sit around all the time. I've never attended an engineering convention but that he was on his feet 80 per cent of the time." Why is it that the average man resents loquaciousness on the part of an engineer? The law of probabilities indicates that the talkative member must be correct part of the time, even if he knows nothing. To be able to talk does not require that we take one of these much advertised "courses." All we need do is to collect our thought beforehand and find out what we know a few days ahead of the speaking contest. Try your hand on these ten questions:

Ques. 1—In an ice tank the brine is circulated by a motor-driven propeller. Assuming that one horsepower is delivered by the motor to the propeller shaft, does all this power reappear as heat in the brine?

Ques. 2—Was the first Scotch marine boiler built in the United States or in Great Britain?

Ques. 3—Will more work be done in raising one pound of air or one pound of water from 15 lb. to 150 lb. abs. and delivering it into the discharge line?

Ques. 4—What is the cause of a turbine changing speed rapidly, giving it the so-called "hunting" effect?

Ques. 5—What is meant by the "apparent" and "real" cutoff of a steam engine?

Ques. 6—How would you set the safety cams of a Corliss valve gear?

Ques. 7—How would you increase the speed of any engine using a spring-loaded governor?

Ques. 8—How can you prevent boiler fractures due to caustic embrittlement?

Ques. 9—Is it safe to use a steam cylinder oil for the cylinder lubrication of an oil engine?

Ques. 10—If a two-phase 440-volt motor, with its stator coils connected series, had its winding regrouped in three-phase series-star, how many volts would the winding be good for?

What Is R in the Equation $PV = RT$?

By W. V. Fitzgerald

THERE are two things that must be remembered in considering any calculation on the behavior of air. One of these is that heat is really something having two dimensions—quantity and degree. It is not something in the nature of a mystery.

It is to be remembered that heat and temperature are quite different. Temperature indicates the *degree* or *intensity* of heat, while a *quantity* of heat is denoted by units arbitrarily called British thermal units.

The formula $PV = RT$ describes the behavior of a unit weight of a perfect gas. This expression is found to be practically correct for real gases at normal temperatures, but it does not accurately express the relations existing for gases at temperatures of —221 deg. F. and lower, and high pressures of several thousand pounds. The relation expressed by this equation between pressure, volume, and temperature is well known to engineers and need not be discussed. The significance of the constant R is not, however, so well known.

In order to arrive at an understanding of R it is necessary to discuss the specific heat of air.

When a pound of iron is heated and its temperature raised one degree, there is but a slight change in the volume of the pound of iron. There is, however, a definite quantity of heat required to raise the temperature of the pound of iron one degree. This quantity of heat is known as its specific heat.

When a pound of air is heated, two things may take place because of the elasticity of the gas. The air may be permitted to expand while the pressure remains constant, or the volume may be made to remain constant while the pressure is allowed to increase. This is a decidedly different condition from that of the pound of iron, where expansion has no appreciable effect on the specific heat.

If a pound of air is heated until its temperature is raised one degree, and at the same time its pressure kept constant, the volume of the pound of air will be increased. In effecting this increase of volume, work is done by the expanding air on the air outside the container. Not only is energy put into the air to raise its temperature, but more heat is added to perform the work of increasing the volume of the pound of air. The amount of heat required per pound has been determined by experiment as 0.2375 B.t.u. This is the specific heat at constant pressure, and is expressed by the symbol C_p.

If a pound of air is heated until its temperature is raised one degree, at the same time keeping its volume constant, there will be a rise in the pressure of the air. In effecting the increase in pressure, only that work is done which will cause the molecules to vibrate more rapidly. No external work is done by the air; consequently, there is less energy consumed by the air. The heat required per pound of air has been determined as 0.1689 B.t.u. This is the specific heat of constant volume, expressed as C_v.

The difference between the heat required to heat a pound of air at constant pressure and at constant volume is 0.0686 B.t.u.

This figure represents heat and may therefore be translated into terms of foot-pounds by multiplying by 778. If the pressure is based on the square foot as the unit, the figure representing R becomes $0.0686 \times 778 = 53.37$.

The value of R can be arrived at by a different method. The density of any gas varies inversely as the volume. If 0.0807 is the weight of one cubic foot of dry air at atmospheric pressure and 32 deg. F., the volume of a pound of air is the reciprocal of this, or 12.39 cu.ft.

Air expands $\frac{1}{491.4}$ of its volume for each degree rise in temperature. Thus if the temperature of a pound of air is raised one degree, the external work done is $\frac{12.39}{491.4} \times 2{,}116.8$ (atmos. press. per sq.ft.) $= 53.37 = R$.

It is interesting to note that the value of R, arrived at by these widely different methods, is identical.

R represents that amount of heat or work supplied or consumed over and above that supplied in raising the temperature of a unit weight of a perfect gas one degree at constant pressure, and which amount is used in performing external work in pushing back the atmospheric pressure during the expansion necessary to accommodate the increased volume of air.

A simple example of the use of R in the formula is as follows:

A tank having a capacity of 150 cu.ft. contains 50 lb. of air and its temperature is 80 deg. F. It is desired to find the pressure.

Since the total volume of the air is 150 cu.ft. and since there is 50 lb. of air, a single pound of air will occupy 3 cu.ft.

Therefore, $V = 3$ cu.ft., T, or absolute temperature $= 80 + 460 = 540$. From the formula $PV = RT$, $P = \frac{RT}{V} = \frac{53.37 \times 540}{3} = 9{,}600$ lb. per sq.ft. pressure, or $66\frac{2}{3}$ lb. per sq.in.

In a Vapor Type Heating System the air that has been forced from the radiators and other parts of the system into the return line must be eliminated, and this is frequently done by having the return line open to the air. A more usual arrangement is to discharge the air through a vent trap. This trap is installed so that the water will ordinarily pass around it on the way back to the boiler, but the air goes to the trap and escapes through the vent in the vessel. Should the water in the return line rise above normal, it will then enter the trap and cause a float to rise, which closes the trap, thus preventing the loss of water from the system. In many systems the trap is equipped with a thermostatic valve that prevents the loss of steam through the vent and also prevents the return of air to the system when the pressure drops below that of the atmosphere. With a system so equipped, it is possible to maintain a slight vacuum during light load periods.

Erratum. On page 434 of *Power* for Sept. 20, 1927, Fig. 3 shows a design of steam turbine built by Brown, Boveri & Company. The name of the designers was inadvertently omitted, and belated credit is here given for the source of this drawing.

EDITORIALS

F. R. LOW, *Editor*

The Factor of Evaporation

ENGINEERS are conservative and continue to use many terms that seem to have outlived their usefulness. Some of these are now under debate, as for instance the boiler horsepower. Another term of questionable usefulness is the "factor of evaporation."

This factor is the term by which the actual evaporation must be multiplied to find the equivalent evaporation from and at 212 degrees Fahrenheit. It is found by dividing the total amount of heat per pound of steam added by the boiler, by the latent heat per pound at 212 degrees. Since the latent heat per pound of steam at 212 degrees is not the same in all steam tables, the factor of evaporation varies, depending upon the particular steam tables used. The answer desired in every case by the use of this factor is the equivalent evaporation of the boiler from and at 212 degrees.

This equivalent evaporation can be found directly by multiplying the total steam evaporated by the total heat per pound of steam added by the boiler and dividing the result by the latent heat per pound at 212 degrees. Why, then, interpose an intermediate term, namely, the factor of evaporation, in this simple calculation? It has no physical significance nor does it in itself indicate any special ability or performance of the boiler. In other words, it is a numerical term and that is all. When the result can be found so easily by the direct method, why retain the apparently unnecessary term of factor of evaporation?

A Half Century of Engineering Service

IT HAS been said that the industrial progress of a nation is recorded in the proceedings of its engineering societies. Similarly, civic accomplishment in a community usually reflects the attainments and zeal of its engineers or, more particularly, of its local engineering bodies.

The Engineers Club of Philadelphia, which has just celebrated its fiftieth birthday numbers among its members, past and present, men whose contributions to science, education, industry and transportation have left their impress both locally and nationally. Moreover, the Club, in addition to having a membership of over seventeen hundred, has become the center for the local activities of seventeen engineering societies, representing an affiliated membership of thirty-five hundred.

Obviously, this has been brought about by offering something more than a place for engineers to congregate. That the Club is an organization with a soul, represented by good fellowship and an indomitable will toward accomplishment, is conceded by those who have been privileged to come in intimate contact with it.

Credit to a large degree belongs to the Club's energetic secretary, Charles E. Billin, whose presence lent a touch of romance to the anniversary. Not only was he one of the organizers of the Club fifty years ago, but its first secretary. After two or three years as such, he resigned, devoting the next forty years to engineering practice and returning in 1920 to become again the permanent secretary, which office he administers with a degree of activity that would tax the energy of a man half his age. In conferring honorary membership upon Mr. Billin, at the banquet, the trustees performed a gracious act.

Power felicitates the Engineers Club of Philadelphia on attaining the half-century mark and predicts that in the next fifty years it will add even greater laurels to its record of accomplishment.

Acceptance Tests

MOST purchase agreements include a guarantee of the performance of the equipment being bought. In accepting performance guarantees, the purchaser assumes an obligation as well as the manufacturer. It should be his duty to have this equipment tested, either in his own plant or when possible in the manufacturer's shop, in order to determine whether guarantees have been fulfilled.

Such a course consistently followed by all purchasers and the strict enforcement of guarantees would soon make manufacturers realize that over-guaranteeing performance in an effort to secure a sale is an expensive policy.

When tests are contemplated, both parties should agree in detail, before the equipment is bought, regarding how and where the tests are to be made. Whether they are made in the manufacturer's shop or in the purchaser's plant is a matter of convenience and depends upon which location will yield the most reliable results. Other things being equal, the tests should be made in

the manufacturer's shop as this affords a better opportunity to make whatever mechanical changes may be advisable in order to make equipment meet guarantees, and also tends to prevent disagreements.

Upon whom the burden of paying for the cost of acceptance tests falls is a live question. At present the usual practice is that tests made in the manufacturer's shops are paid for by the manufacturer, while tests made at the plant are paid for by the purchaser. In the last analysis, however, the purchaser bears the expense of whatever tests are made, since the expense to the manufacturer is added to the purchase price. That is the purchaser's part of the joint obligation.

When Is An Engineer?

WHAT to call the man who operates machinery is a question that is discussed now and then, but nobody seems to get anywhere by the discussion.

A recent development is the official adoption by a large contracting firm of the substitute terms. The man who operates stationary equipment, such as an air compressor, a hoisting engine, a pump or a power plant, is known as an *operator*. He who drives moving equipment, such as a locomotive, a locomotive crane train or a tractor, is known as a *runner*.

There are those who would confine the terms *engineer* to men who have accomplished a certain type of education in a definitely specified manner, altogether forgetting that the degree of a man's education is an intellectual rather than an academic degree, and that it is quite independent of how he acquired his ability. Engineering capacity is not a matter of memorizing facts from a book, or even from a laboratory, but it is rather an ability to see facts clearly, to think straight, and to act promptly, to the end that effective measures may be taken to the accomplishment of the desired result.

Our European friends spell the word correctly. They call an engineer an *ingenieur*. The name comes from the Latin word *ingenium*, from which is derived our word *ingenuity*. From the point of view of our language structure an engineer is a man who is capable of exhibiting ingenuity. Custom has naturally restricted the use of this word to particular fields of activity, but, nevertheless, it appears that this criterion is not a bad one in deciding who shall be called an engineer. Some men carry the title who certainly do not meet this test.

And this applies just as often to the college graduate as to the man of more limited formal schooling. Others qualify richly under a requirement of this sort, whose formal academic training would never entitle them to any of the conventional "degrees" that mean so little in indicating the real qualifications of men.

On the whole, it would seem that little is to be gained by calling a man an *operator* or a *runner*. The latter term, particularly, might be taken to imply that he works more with his feet than with his head, and while it is true that some men who call themselves engineers seem to be in this unfortunate category, nevertheless, it is a pity to deny to a large class of men a title to which most of them are fully entitled, because a minority of their associates are obviously ill-qualified to do honor to the title.

Nobody objects to calling all sorts of people by the term *business man*. This covers all manner of men from the presidents of our biggest financial and industrial institutions down to the corner groceryman, and perhaps even the newsboy. Business is a broad term, and everybody knows that a business man is simply a man engaged in some variety of business undertaking. Similarly, engineering is a field whose breadth is constantly surpassing our imagination, and most intelligent people understand that a man indicated as an engineer is simply one who is working in some capacity in a restricted portion of this vast field. In other fields it is not customary to differentiate finely in the assigning of labels to classes of people. Why be so fussy about the engineering field?

Imagine the Savings!

IMAGINE what a difference it would make in the power and maintenance requirements of some industrial plants if the lubrication of the production equipment were as efficient and economical as the lubrication of the units in the power plant. Lubricants cost money and so do repairs. Too much, too little, or wrongly applied lubricants may not attract much attention at the time of application, but, when the monthly or yearly cost sheets appear, the effect is evident although its cause may not be recognized.

The ability of the power engineer to handle lubrication in the best way is seldom taken advantage of by the management. So, when improper lubrication puts an extra burden on the power plant, all the power engineer has to do is to generate the added power. Of course, he could call attention to the improved lubrication service that he could render. But that would only add to his existing troubles.

And the management is not likely to see the cost of poor lubrication, hidden away, as this cost is, among other larger items of expense. But if they did happen to find out and then turned this important service over to the power engineer, imagine the savings that could be made!

A QUESTION TO BE ANSWERED in the future by the engineer and economist is: What effect on the marine Diesel will result from the development of pulverized coal equipment for use with Scotch marine boilers? Tests indicate that powdered coal can be handled successfully

IDEAS *from* PRACTICAL MEN

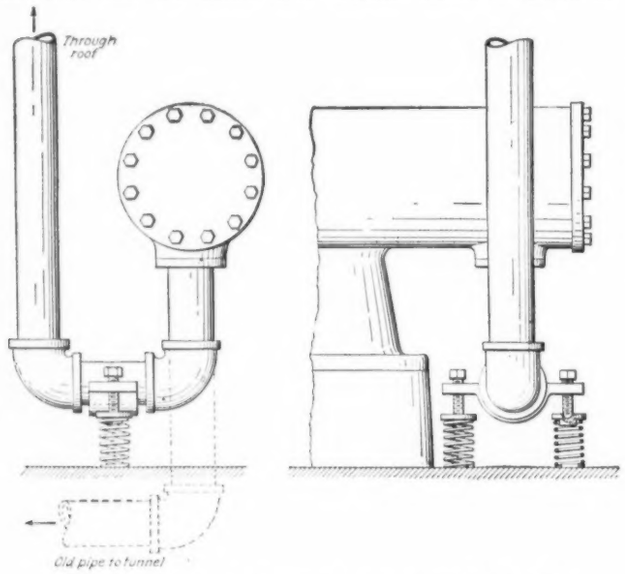
Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Spring Support for Exhaust Pipe

A SIX-INCH exhaust pipe from a gas engine discharged into a tunnel, and while this arrangement quite effectually muffled the sound, the exhaust gas became objectionable in the tunnel and the pipe had to be changed to discharge in some other place.

It seemed that the only way out of the building with the new pipe was through the roof, so the old pipe was cut off at the floor line. The stub piece was then screwed out of the exhaust connection on the engine, cut off and threaded, short enough to allow an elbow to be screwed on the bottom end and clear the floor about six inches.

A piece of pipe long enough to allow the vertical pipe, which went through the roof, to clear the cylinder was screwed into the elbow and another elbow screwed on



Spring cradle supports weight of exhaust pipe

the other end of this pipe, after which the vertical pipe was screwed into the second ell.

This placed quite a strain on the engine from the weight of the pipe, so some way had to be devised to support the pipe. If wedged so that the weight of the pipe came on the floor, the expansion when hot would also throw an undue strain on the engine cylinder, so a cradle was made from a piece of ½x2-in. iron, bent to the radius of the pipe and a hole tapped in each end for a ¾-in. screw.

Two heavy springs were then secured, the cradle and springs assembled under the short horizontal pipe and the screws tightened until the springs took the weight of the pipe, as shown in the illustration.

This arrangement allowed for expansion and also relieved the cylinder of any strain due to the weight of the exhaust pipe. P. ELLIOTT.

Topeka, Kan.

Why the Duplex Pump "Quick- and Slow-Stroked"

THE writer of this letter has had more than twenty years of practical mechanical experience, covering almost all kinds of power plant apparatus, both obsolete and modern.

A man with this much experience naturally feels that he has absorbed quite a lot of knowledge, but generally when he begins to get chesty about what he knows and to think that all that other men have to do to be wise is to wear his hat for a little while, something comes along that humbles him and teaches him that he has either forgotten part of it or hasn't learned it all yet.

An incident of this kind happened recently, which will illustrate this statement and may help some other man out of difficulty by refreshing his memory as to the behavior of a duplex pump.

The operating engineer reported at about 4 p.m. that a duplex boiler feed pump was not working properly, and I immediately set about correcting the trouble.

This pump fed only one boiler for heating and drying, and from all indications the trouble was in the water end; one side would stroke quickly and the other slowly, and the check valve seemed to seat noisily when the slow side stroked, which would indicate that the packing was gone from the water piston in the side that stroked quickly.

The water cylinder head was removed and the packing taken out of both pistons. As was expected, this packing was badly worn on one side of the pump, but did not seem bad enough to cause the trouble; however, new packing was put in both pistons, the cylinder head replaced and the pump tried again.

There was still an appreciable difference in the speed of the two sides of the pump, but as both sides seemed to operate the check valve, it was decided that one side was packed a little tighter than the other and that everything would be all right as soon as the packing wore a little on the tight side. To make sure that everything was all right, a trip was made to the plant at about 7 p.m., and sure enough, the pump was running slowly and both sides pumping apparently normally, but the next morning there was a note from the night man saying that the pump had given him trouble again and that he had been

compelled to use the auxiliary feed to keep water in the boiler.

When the pump was started the action was found to be much as it had been before. It was then reasoned that there must be an obstruction so that the water could not get either to or from the side of the pump that was running slow.

The suction and discharge lines and passages were examined and found clear, and to make certain that the valves were not at fault, the valve chambers were opened and new valves put in, but still one side would just drag along with the throttle wide open.

It was next decided that the feed pipe was limed up inside the boiler, and in order to make sure, a pressure gage was put on the discharge side of the pump, which quickly showed that the free running side of the pump was the one that was pumping and that the discharge pressure was little in excess of boiler pressure.

This showed conclusively that the feed pipe was clear and that the trouble was in the power end of the pump and in the slow or lazy side. The setting of the steam valves was checked and found to be correct, which led to the conclusion that the steam piston rings were leaking so badly that the steam was equalizing on both sides of the piston and doing no useful work. But in taking off the steam cylinder head to examine the piston, we found a large section of the head gasket was blown out between the cylinders, allowing steam to bypass from one cylinder to the other. Which all goes to show that while 95 per cent of pump trouble is probably in the water end, the steam end can also fool you sometimes. P. ELLISON.

Topeka, Kan.

Anti-Friction Bearing Proves Satisfactory Where Babbitted Bearing Failed

IN the hydraulic plant at Nashua, Iowa, the exciters for the a.c. generators are belt driven from 48-in. pulleys mounted on the vertical shafts between the generators and the waterwheels. The belts run with a quarter-turn, which necessitates idler pulleys about 12 in. in diameter with a 12-in. face. Originally, these idler pulleys were babbitted and ran on nearly vertical shafts about 3 in. in diameter, with grease lubrication. These bearings threw grease and were noisy as soon as there was any wear. They often failed in three days of steady running.

In an endeavor to overcome this trouble one of the idler pulleys was fitted with anti-friction bearings and felt washers. The pulley ran smoothly and quietly without throwing grease. The first unit tried out gave such excellent service that the rest of the pulleys were fitted in the same way. This practically ended bearing and grease trouble and added considerably to the efficiency of the plant.

There are undoubtedly many cases in the various power plants throughout the country where ordinary babbit or sleeve type of bearing could be replaced with anti-friction bearings with equally good results as obtained in this case. In most cases the cost would not be excessive, and considerable saving might be made in the cost of lubrication and a big reduction in the cost of maintenance and repair. C. V. HULL.

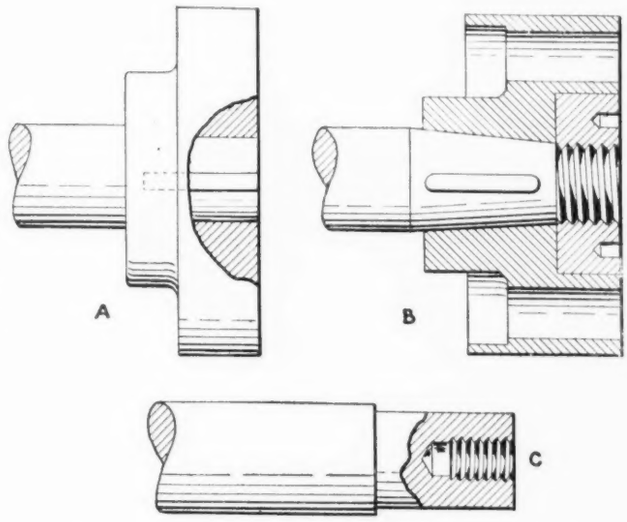
Charles City, Iowa.

Repair Jobs on Small Turbines Frequently Difficult Owing to Design

DURING the past several weeks it has been my privilege to witness several repair jobs on small turbines. In every case the coupling had to be removed, and I have been forced to believe somewhat against my will that all turbine builders are not in sympathy with the repair gang.

For instance, in one case, where room was at a premium, the coupling had been forced on at the factory, and two hours' heating and a pull of six tons was necessary to remove it. When it was replaced (also heated), it stuck and had to be mauled the last three-eighths of an inch.

In the same plant another turbine was under repairs,



Different methods of fitting coupling to shaft on small steam turbines

and this coupling was provided with a taper fit and threaded spindle for pulling it on, as shown at *B* in the illustration.

In the first instance eleven hours were required to complete repairs and in the second, something over six hours.

In one case sometime ago, a hole was drilled and tapped for a 1-in. bolt as at *C* and the coupling was heated and drawn on by means of the bolt. It always has looked more or less crude to me to see men slugging on couplings, when they can just as well pull them on or use a hydraulic press. And again, some turbine makers design and build machinery so that only factory tools will fit and all repairs will presumably have to be made by the factory.

After dealing with one company, an experiment was made. The turbine owner had patterns and castings made locally and the machine work done in his own shop. The entire cost was less than half that of the manufacturer, and the job was equally as good.

One impractical design I came across was in a small turbine where the shaft governor was screwed on with a right-hand thread and setscrews were set down on the thread to keep the governor from unscrewing.

New York City. C. W. PETERS.

COMMENTS *from* READERS

What Is The Best Type of Gas Burner For Small Combustion Space?

I SHOULD like to have some suggestions from readers of *Power* on how to fire natural gas efficiently in a Scotch type of two-pass boiler, designed for coal burning. Other details of the boiler are: Heating surface 1,000 sq.ft., hand-fired, 70-ft. stack, 4-in. first-pass tubes and 3-in. upper-pass tubes; heating value of gas, about 1,080 B.t.u. per cu.ft.; boiler pressure desired, 5 lb. for heating; gas pressure, 5 in. of water.

What kind of burner should be used in this small combustion space to get maximum efficiency and flue-gas analysis? Do the large tubes have any effect on the efficiency? If so, how can this be readily helped? Any information will be appreciated. C. W. STEVENS.

Tulsa, Okla.

* * * *

Improper Distribution of Air on Underfeed Stoker Causes Grates to Burn Out

I HAVE been much interested in the discussion in recent issues of *Power* of the question of air distribution in underfeed stokers and the burning of grates, as outlined by Mr. Croft in the Oct. 18 issue and commented on by Mr. Tray in the Nov. 15 issue.

I am wondering if any consideration has been given

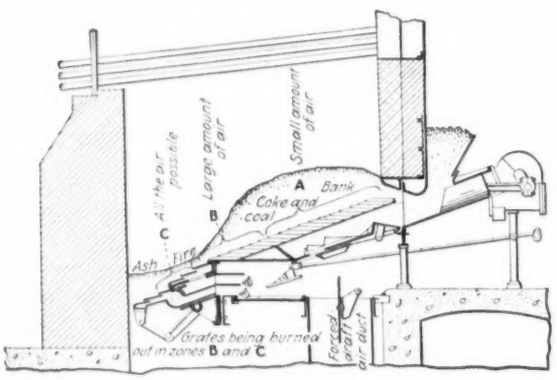


Fig. 1—Plan of air distribution used by fireman No. 1

to the question of stoker length and its bearing on the depth of fuel bed necessary to carry the desired load, and on air distribution.

In the plant with which I am connected, we are using underfeed stokers six retorts wide and seventeen tuyères long installed under 5,000-sq.ft. water-tube boilers. The projected grate area is 90 sq.ft., including the dump plate. This is considered a short stoker and necessitates a fairly heavy but short fire. Our fuel is high-grade Eastern coal running about 76 per cent carbon, 18 per cent volatile and 6 per cent ash and having a heat value of 14,500 B.t.u. per pound.

In our particular case it is not probable that 75 per cent of the fuel is burned in the first half of the stoker designated as section *A* in Fig. 1, reproduced herewith,

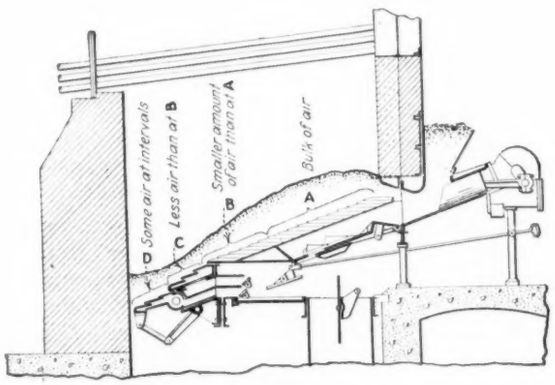


Fig. 2—Plan of air distribution used by fireman No. 2

nor is it probable that 75 per cent of the coal can be burned there, as the fuel bed is quite thick and dense at that point, tapering off thinner at point *B*, and it is our policy to admit all the air that the grate will pass at point *C*.

I recall having read several years ago a bulletin from the United States Bureau of Mines covering exhaustive tests on a small model furnace to determine the composition of the gases at various points up through and above the fuel bed, and it was found that the gas at and just above the fuel bed surface was rich in CO and any attempt at forcing sufficient air through the fuel bed to burn the CO to CO_2 only resulted in producing a larger quantity of gas of the same CO content; in other words, it simply increased the rate of fuel burning without changing the character of the gases, and in order to burn the rich gas more completely, secondary air had to be admitted over the fire.

It is my contention that for our particular case and possibly in the case of Mr. Croft the method of No. 1 fireman was correct, and to substantiate my theory I can show an operating condition of an average of 13 per cent to 14 per cent CO_2 in the rear pass of a three-pass boiler and a flue-gas temperature in the same pass of 525 deg. F. at 150 to 175 per cent rating on the boiler. These figures would not indicate much loss from excess air admitted at point *C*, as this excess constitutes the "secondary" air necessary to consume the rich gas distilled at point *A*.

Furthermore, it is my opinion that the grates are more likely to burn with a heavy fire and minimum air than with bare grates and excess air.

It has been my experience that more grates are burned with fires in a banked condition than when operating under load, the reason for this being that under banked condition the fire burns down to the grate, and since no air is passing through the grate there is no cooling medium to absorb the heat, and the grates burn.

North Plymouth, Mass. C. B. HUDSON.

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Furnace Temperatures With Natural Gas

IN THE Nov. 22 issue the question is asked, "What furnace temperature would you expect to obtain with natural gas?" The answer given is, "With 10 to 20 per cent excess air gas firing gives a furnace temperature of not over 2,000 deg. F."

If we are expected to accept this literally and without further qualification I would say the answer is wrong. To begin with, in boiler furnaces it is my understanding that ratings, rather than excess air percentages, have the greatest influence on furnace temperatures. Combustion space also is a factor. This is a natural-gas burning territory—about 80 per cent saturated, I should say—throughout Louisiana and east Texas, and it is not uncommon to find furnace temperatures of 2,300 to 2,500 and more, sometimes under boilers operated at 200, 250 and to 350 per cent ratings; then there are glass furnaces which require well over 2,500 deg. at times, not to speak of welding furnaces operated with natural gas running close around 3,000 deg. Almost any good burner manufacturer can guarantee not over 15 per cent excess air in samples taken at the first pass in boiler furnaces, and your percentages are taken for granted. Of course higher percentages of excess air will result in cooling and a consequent lowering of furnace temperatures with a rise in stack temperatures.

If one should rely on the answer given, for specifying refractories down here, we would run into trouble.

Shreveport, La. H. M. GODSEY.

* * * *

Mercury Liquid Level Gage

THE practical suggestion of the flow telltale for water tanks in the Sept. 6 issue brings up the thought of a simple telltale for the quantity of liquid contained in such tanks.

While there are many liquid level gages available that show the height of the liquid in a tank, it is easy to construct a simple mercury gage that will give the quantity of liquid directly in gallons, cubic feet, or any desired units, as well as the level, without calculation or the purchase of special instruments.

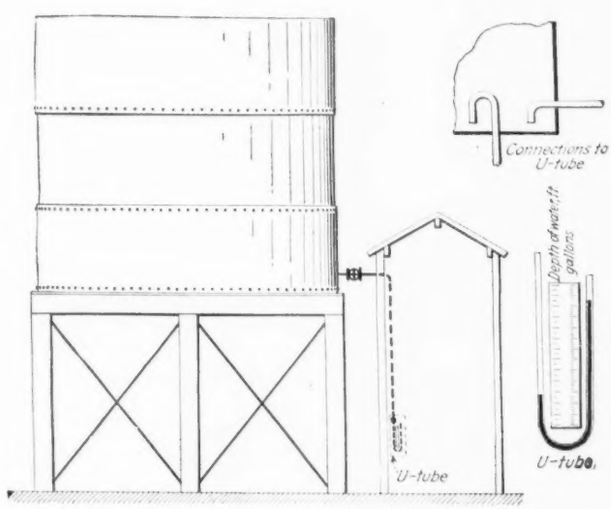
The accompanying illustration shows a glass U-tube containing mercury, connected to the tank at the lowest point that the level of liquid is expected to drop at any time. The U-tube should be calibrated in even height units and quantity units.

For example: one inch of mercury corresponds to 13.6 in. water, and the graduations for liquid level would be made to correspond to, say, feet of water by making each division of the scale $\frac{12}{13.6}$ of an inch of mercury. On the same scale the volume of liquid corresponding to such divisions, based upon the size of the tank, can be placed.

The height of the mercury column would depend on the height of the tank, approximating one inch of mercury for every foot of water. A zero calibration would be necessary to compensate for the column of liquid contained in the lead line from the level of the gage to the bottom of the tank.

Should the tank be below the mercury gage, a depth of approximately 32 ft. of water below the gage would render the gage inoperative, in that a vacuum would be produced in excess of a mercury column corresponding to the local barometer reading.

Proper corrections should be made for the density of the liquid measured, in cases where solutions, oil, etc., are used. Care should be taken, when connecting the gage to the tank to protect against clogging by sediment, etc., such as would occur if the line were connected to the bottom of the tank. The details on the sketch show two methods of connection.



Mercury telltale and method of connecting to tank

A mercury column has advantages over a standard pressure gage in that it requires no resetting or calibrating and is more accurate and dependable.

For outside tanks the U-gage can be placed inside the building at convenient points. L. G. JONES.

New York City.

* * * *

Why Do Boilers Shake?

REFERRING to the query of E. E. Clock in the Sept. 27 issue on "Why Do Boilers Shake?" it seems to me that his statement in the last paragraph, "It may be significant to note that this trouble is never encountered in boilers feeding turbines, because the flow of steam is constant," is rather broad.

Combustion is the most important feature, or rather the most common cause, and particularly in oil-fired boilers. Improper mixture of oil and air will cause a boiler to pant and shake so badly that it seems as if it would fall apart regardless as to whether it is supplying a turbine or any other type of engine.

Boston, Mass. EARLE S. NASON,
Chief Machinist, U. S. Navy.

Filling Engineering Positions

I LIKE the consideration given applicants for engineering jobs, by S. G. Williams, in his article on "Filling Engineering Positions," in the Nov. 1 issue. I refer to the attitude of confidence and protection to the applicant.

However, I do not think that the employer should communicate with the firm that presently employs the applicant. If the applicant fulfills all other requirements and the selection narrows down to last choice, his present employers should not be consulted at all.

In the first place, they may be loath to lose the man and may not give the full unbiased facts. This often happens and gives the applicant an undeserved set-back.

In the second place, it violates the applicant's confidence, in that you might as well write to his employer at first if you write without having hired him. His chances of being employed are still in the balance, so that if he is disappointed, he is in just as bad a position.

I know that it is the policy of several personnel managers of large public utility companies not to violate the applicant's confidence at any time. They will not confer with the present employer at all.

I believe that this is the only truly fair-minded way to treat applicants. I do not think it necessary for the present employer to know anything about a man's desire to make a change, "if the applicant indicates that such is his desire."

FRED EMMARR.

New York City.

* * * *

Proper Distribution of Air on Underfeed Stokers

WITH reference to the inquiry of J. J. Croft in the Oct. 18 issue, as to the proper distribution of air through the various parts of a multi-retort underfeed stoker, my opinion is that the air distribution used by fireman No. 2 is the correct one.

In a multi-retort underfeed stoker, green coal is, of course, supplied only in the underfeed section. Consequently, it is in this section that distillation of the green coal takes place, and at the same time there is nearly total combustion of the coke thus formed. Then, to burn these gases and the coke, it is necessary to admit in this section the largest portion of the total air.

Moreover, as the fuel bed travels toward the rear of the stoker, it is obvious that the amount of combustible remaining in the fuel bed or, rather, in the refuse, is decreasing more and more. Therefore, to obtain a good combustion, the amount of air to be supplied in the various sections at the rear of the stoker is to be proportioned to this decreasing percentage of combustible.

This opinion I have advanced and patented many years ago (see U. S. Patent Re. 15,462), has proved itself to be correct in practice and is plainly corroborated by the use of this method of air regulation and distribution in all the modern multi-retort stokers.

In addition to the troubles experienced with the air distribution used by fireman No. 1, my opinion is that the efficiency is considerably lower than with the air distribution used by No. 2, for undoubtedly an excess of air is admitted in the lower parts of the stoker and a deficiency of air in the upper parts. The result is a poor CO_2, a smoky combustion and hence a poor efficiency.

Paris, France. M. RATEL.

Answers to What Do You Know

The questions are on page 1020

Ans. 1—The power delivered to the propeller is used in the slippage of the blades and in maintaining the velocity of the brine. The brine, after once being set in motion, could continue indefinitely were it not for the inter-fluid friction and the friction between the brine and the piping, etc. This frictional heat is equivalent to the power delivered by the propeller, and this heat, as well as the heat developed at the blades, must be removed by the ammonia. The heat leakage through the tank sides is insignificant and has been ignored.

Ans. 2—Erastus W. Smith, an American engineer, designed the first Scotch marine boiler in 1851. This was installed on the ship "Hermann."

Ans. 3—The air will require much more power. Assuming both air and water are at 60 deg. F., one pound of air will have a volume of 12.8 cu.ft. and one pound of water will have a volume of 0.016 cu.ft. The work of compressing and delivering a pound of air can be found by the formula,

$$Work = \frac{144\,P_1V_1}{1.41-1}\left[\left(\frac{P_2}{P_1}\right)^{0.29}-1\right]$$

Substituting the values of $P_1 = 15$ lb. per sq.in., $P_2 = 150$ and $V_1 = 12.8$ cu.ft., we find that the work in foot-pounds is 64,062. Water is practically incompressible, so it is admitted into the cylinder at 15 lb.; immediately the pressure is raised to 150 lb. and the water is being discharged from the beginning of the stroke. The force exerted is then the pressure difference multiplied by the volume swept out by the piston, or work $= 144\,(150-15) \times 0.016 = 311$ foot-pounds.

Ans. 4—This is due to friction in the governor joints or linkage.

Ans. 5—The fraction of the stroke completed by the piston up to the point where the valve covers the steam port is called the apparent cutoff. But not only is this per cent of the volume swept out by the piston in its entire stroke filled with steam, but in addition there is steam in the clearance space. The "real cutoff" is the sum of these two volumes divided by the sum of the piston displacement and the clearance volume.

Ans. 6—When the cutoffs have been equalized, drop the governor to its lowest position and set the safety cams around to such positions that they will prevent the latches from picking up the valves. Next raise the governor to its highest position and see if the cams prevent the valves from being packed up. If not, readjust to prevent the valves opening.

Ans. 7—Tighten the governor spring slightly.

Ans. 8—Add sulphuric or hydrochloric acid until the boiler water is either neutral or slightly acid.

Ans. 9—Yes. This is being done on a two-stroke-cycle Diesel in the Los Angeles water works where the usual cylinder oil proved unsatisfactory.

Ans. 10—A two-phase series winding, when connected three-phase series-star, is good for 125 per cent of the two-phase volts. In this problem $440 \times 125 = 550$ volts.

The relation allows regrouping the winding in a 440-volt two-phase motor for 550 volts three phase. Conversely, the winding in a series-star connected, 550-volt three-phase motor may be regrouped to operate 440 volt two phase.

New and Improved EQUIPMENT

Marley Steam Purifier

A NEW specialty of the Power Plant Equipment Company, of Kansas City, Mo., is the Marley steam purifier. It is mounted outside the boiler on the outlet nozzle from the steam drum, where it is easy to install and accessible for inspection. Provisions are made to drain internally to the boiler or externally to a settling drum or steam trap.

Reference to Fig. 1 shows the purifier mounted on top of the nozzle of the steam drum. The sectional view, Fig. 2, shows that the purifier consists of an outer bowl and an inner whirl chamber. Steam from the boiler drum passes upward through the nozzle into the bottom of the purifier, where it is equally distributed in the annular space between the walls of the outer bowl and the whirl chamber. Thus, as the steam is drawn from the boiler, it passes upward through this annular space of the purifier and downward through a nozzle ring equipped with large open nozzles or vanes, which is attached to the top and just inside the whirl chamber. As the steam passes through these nozzles into the purifying chamber, it is given a centrifugal, or whirling, motion, by which the impurities and moisture in the steam are thrown outward on the walls of the chamber, where they are entrapped by vertical ribs lining the entire periphery. The purifying chamber is inclined outward and downward, causing the moisture and solids to settle out. To make this settling action feasible, the lower portion of the chamber is provided with a number of crowfoot baffles that tend to eliminate the whirling motion in the lower part of the chamber, while the whirling action continues in the upper portion. The drainage is effected externally through the opening at the periphery or internally through the opening at the center of the chamber, the steam finally passing upward and out through the opening at the top.

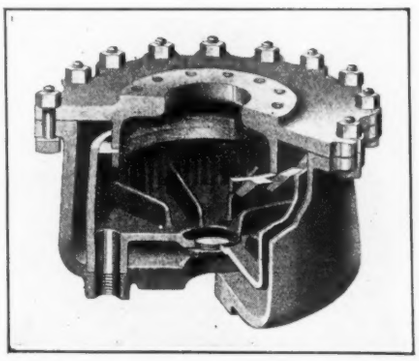


Fig. 2—Section through purifier, showing construction and principles of operation

The purifier is being made in several sizes to meet the capacity requirement of the various types and sizes of boilers now in general use.

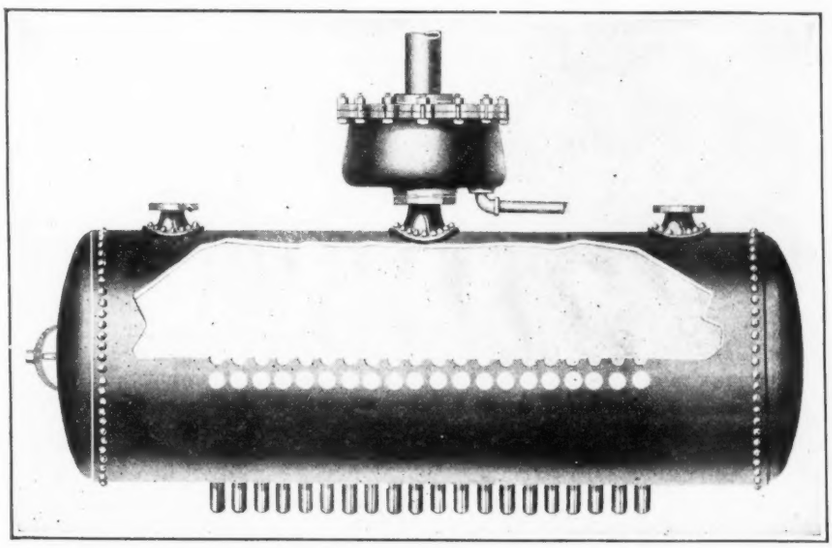
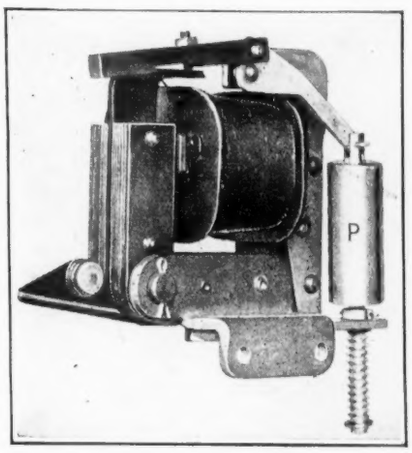


Fig. 1—Marley steam purifier mounted on outlet nozzle of boiler drum

Device to Delay Motor Being Tripped Off the Line

FOR those applications that are liable to voltage drops of short duration, the Westinghouse Electric & Manufacturing Company has designed a time delay attachment for use on standard low-voltage release equipment. This attachment is of particular advantage in paper mills and in other continuous processes where it would be a great inconvenience to have the motors of the plant shut down owing to momentary dips in voltage.

The new time-delay device, shown in the figure, is provided with adjustment which allows the low-voltage release to open from one-half to two-and-one-half seconds after the voltage drops below the minimum value. If the voltage remains low longer than the time for which the time-delay device is set, the motor circuit will be opened and the equipment protected from excessive currents. This device will keep motors from shutting down owing to short harmless surges caused by temporary short-circuits or decreases in voltage due to switching. The usual method of starting and stopping with the compensator handle is not affected in any way by the addition of the time-delay attachment.



Time delay low-voltage device for Westinghouse auto-starters

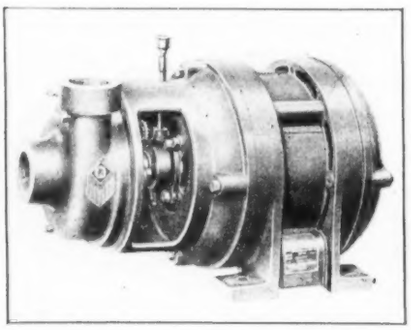
The new attachment may be applied to any standard, Westinghouse auto-starter, in service as easily as at the factory, since it mounts in the same mounting holes as the standard low-voltage mechanism.

The time-delay attachment consists of a low-voltage magnet that has a dashpot for retarding its opening. After opening slowly a certain distance, a latch releases the magnet so that the starter opens quickly in the usual way. The time adjustment is obtained by varying the position of the fulcrum of the release latch.

Allis-Chalmers Type "SSU" Centrifugal Pumping Units

THE illustration shows the type SSU centrifugal pumping units recently brought out by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., in which the motor and pump are combined in one unit.

The unit is close-coupled by fastening the pump impeller to one end of the motor shaft and bolting the pump casing to a special integrally cast extension of the motor end housings. This construction eliminates a baseplate, coupling and pump bearings and precludes the possibility of misalignment between the



Combined motor and centrifugal pump

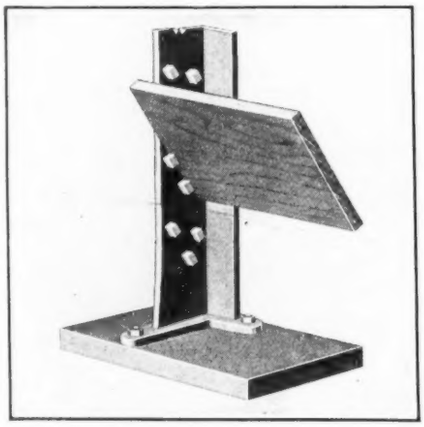
pump and motor. The motor is fitted with over-size tapered-roller bearings, having ample thrust and radial capacity.

The pumps are built in 1¼, 1½, 2 and 2½-in. sizes and can be used with 1, 1½, 2, 3, 5 and 7½-hp. motors. The capacities handled range from 25 to 200 g.p.m. against heads of from 50 to 100 feet.

Marley Louvre Post

A NEW type of louvre post designed to facilitate the building of louvre fence for spray ponds or cooling towers, has been brought out recently by the Power Plant Equipment Company, of Kansas City, Mo. The posts are of running and corner types, and are made of cast iron with studs so cast on the outside as to form slots for 1-in. standard boards. As indicated in the accompanying illustration, the fence building is a simple job. After the posts have been erected, it is merely a question of slipping the boards into the slots on the posts.

This feature has also been incorporated in the new Marley spray cooling tower which embodies a number of unusual features, such as the use of spray nozzles for water distribution at the top instead of the conventional wooden troughs or launders and the elimination of the wooden inner deck construction. The louvred sides have a cast-iron supporting frame construc-

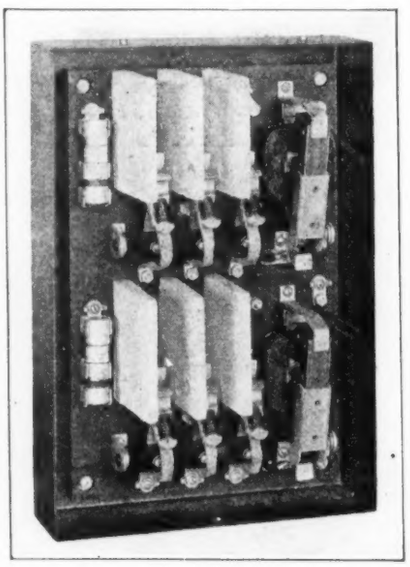


Detail of Marley louvre post

tion, and the louvre boards are slipped into slots in the same way as shown for the louvre posts.

Small Magnetic Reversing Switches

THE General Electric Company announces a line of small switches for miscellaneous application as across-the-line reversing switches for small motors. One style of these switches consists of two 15-ampere, double-pole contactors electrically and mechanically interlocked and inclosed in a drawn-shell case. They are for use with momentary-contact push-button stations and may be had with or without overload relays.

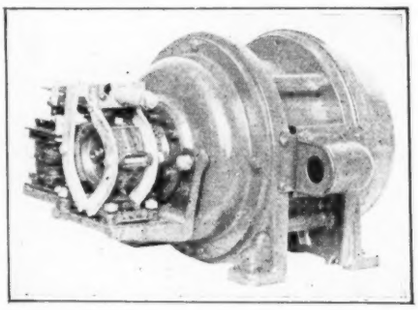


Three-pole 25-ampere reversing switches

Another style of switch consists of two three-pole 25-ampere contactors mechanically and electrically interlocked, shown in the figure, for use with a momentary-contact push-button station and has overload relays. Typical applications are wherever a small magnetic reversing switch is required, such as machine tools and motor-operated valves.

G. E. Totally Inclosed Motors for Portable Hoists

THE General Electric Company has recently brought out a new line of motors for portable electric hoists and suitable also for other applications involving intermittent operation and high starting torque. The line runs from one to ten horsepower in the direct-current types; from one to eleven horsepower, single-speed, three- and two-phase, and from one to five horsepower, single-phase, in the alternating-current types. Three- and two-phase slip-ring



Hoist motor with brake

type hoist motors are also included from three horsepower up.

The new motors are totally inclosed, and all parts are protected. Bearings are of the waste-packed, sleeve type, being closed against the entrance of dirt from the outside. The direct-current motors are series wound. The alternating-current motors of the polyphase type have high-resistance rotors, while the single-phase motors have an unusually high starting torque.

As in many of the applications of these motors a brake is required, the motors are all built with the shaft extension away from the drive to take a brake, and the motor end-shield at this end is fitted with pads or bosses with drilled and tapped holes for mounting the brake, as shown in the illustration.

J. E. RHOADS & SONS, announce that they are now making their regular brands of belting with waterproof cement and a treatment to make the leather water resisting. This makes it possible to use the belts under either dry or wet conditions.

Pulverized Coal Applied to Scotch Marine Boiler

Summary of Ten-Day Test on Shipping Board Boiler at Philadelphia Navy Yard

PRELIMINARY announcements have appeared in *Power* concerning the pulverized coal tests with a Scotch Marine Shipping Board boiler at the Philadelphia Navy Yard. Complete results of a 240-hour run have recently been made available in a paper before the Society of Naval Architects and Marine Engineers by C. F. Jefferson[1] and Commander J. S. Evans, U.S.N. This boiler has since been installed on the steamship "Mercer" in order to determine by actual operation the real merits of pulverized coal when applied to the existing type of cargo vessels fitted with Scotch boilers.

The project was not entirely new, as in 1920 the Emergency Fleet Corporation had attempted to utilize the conventional stream-line type of pulverized coal burner, but with meager results, as the maximum rate of combustion that could be maintained was 2.5 lb. of coal per cubic foot of furnace volume, or a maximum heat release of 32,000 B.t.u. per hour per cubic foot of furnace volume. In addition to the limited rate of combustion the boiler efficiencies were far from satisfactory, as the combined air heater, superheater and boiler efficiency was only 54 per cent.

Shorter Flame Lengths Possible

Between 1920 and 1925, however, considerable development had been made in pulverized-coal installations. Some definite facts had been established which at the earlier date were hardly even matters of conjecture. Chief among these was the effect of flame turbulence and of superfines in the coal on speeding up the rate of flame propagation. These facts, coupled with the use of preheated air, indicated that, instead of the 20- to 25-ft. flame travel necessary when using the stream-line burner and only ordinary fineness of coal, it would be possible to effect the same completeness of combustion within eight to ten feet of flame travel.

The initial installation made at the test plant consisted of a Fuller-Bonnot unit mill and Fuller-Lehigh well-type burners. The burner installation was not chosen so much from its characteristics of being a practical marine type, for, as a matter of fact, it had several decided disadvantages from this point of view, chief of which was the multiplicity of pipe work required. But rather, it was chosen to determine the combustion conditions that could be obtained from a turbulent burner which was the direct antithesis of the stream-line burner.

The series of tests did not produce a practical seagoing installation, but they did demonstrate the feasibility of burning pulverized coal in the limited size Scotch boiler furnace. A combustion rate as high as 6.19 lb. per cubic foot of furnace volume was maintained for limited periods of from two to six hours with a heat release as high as 88,330 B.t.u., and a boiler efficiency of 68.7 per cent was obtained for eight-hour test periods. It is to be noted that this boiler was not equipped with either an air heater or a superheater.

Fuel Distribution and Air Control Vital

The principal reasons for the failure to obtain continuous satisfactory service was the uneven distribution of fuel to the twelve burner nozzles and lack of proper control over the air pressures. This type of burner used the entire supply of air necessary for combustion as primary or carrier air, and as the pulverizer was an air-swept mill, any attempt to regulate the air supply affected both the turbulence and the fineness of product from the mill.

In the meantime the Peabody Engineering Corporation had been experimenting with a burner at one of the large power plants, and as this burner appeared to have the characteristics that made possible the peak performance of the above-mentioned installation, and as it was also so designed as to make it suitable for marine use, it was selected for the next series of tests. The mill used on the second series was a high-speed paddle type.

On this series, with comparatively low volatile coal and at moderate combustion rates, fairly satisfactory performances were obtained. The test runs of this series were of comparatively short duration, being made chiefly for the purpose of determining the performance of the burner rather than the complete installation.

The tests covered a range from 33,500 B.t.u. per cubic foot of furnace volume up to 52,000 B.t.u. The boiler efficiencies obtained on two to four-hour periods were from 71 to 78 per cent.

It was found in this series that, with the particular pulverizer installed, with a change in the quality of coal and in the capacity demand rate, there was a considerable variance in the fineness of grind obtained, and as the manufacturers desired to withdraw their mill from the tests until they had completed further development work on it at their own plant, it was decided to install again a low-speed air-swept tube mill.

The mill selected for this purpose was the Kennedy air-swept tube mill, in which the pulverizing medium is a charge of Herculite steel balls. This mill has been used for the remainder of the test work to date, including the 240-hour continuous service run.

Preliminary Runs

The third series of tests consisted of a number of short runs over a period of about six weeks, during which various operating features were worked out, such as correct fan and distributor speeds, ball charge for mill, etc. During this period the operating technic of the personnel was also developed, and it was then felt that we were ready to go ahead with a continuous service test that would demonstrate what could reasonably be expected in service.

The 240-hour continuous service test started on July 27, 1927, and terminated Aug. 6. During this time for 48-hour periods following each other without interruption, combustion rates of 1,200, 1,400, 1,600, 1,800 and 2,000 lb. an hour were maintained.

The only other modification was to provide three holes in the rear of the boiler, each hole being as nearly as possible in line with the center of each furnace. These holes were made by fitting three stay tubes through the rear head and rear sheets of the combustion chambers, and served not only as inspection holes for examining the appearance of the flame, but also as entrances for piping for obtaining gas data.

The mill was equipped at the feed end with an air box having two openings, one a connection to the preheated air pipe, which furnished air for sweeping the mill, and the other for inspection purposes or for adding to the pulverizing charge. At the discharge end was the "primary air" fan, which was motor-driven. This fan took suction through its center and discharged vertically upward. That section of the

[1] Head of Fuel Conservation Section, United States Shipping Board.

fan adjacent to the mill took its suction principally through the mill through the hollow journal on the discharge head. The fan casing of the mill end was, however, equipped with an air box surrounding the hollow journal. When the fan was first installed, this air box was kept closed, but during the preliminary tests it was found necessary and desirable to furnish some air through this box, and, therefore, it was connected to a preheated air duct. During the run this mill end of the primary fan took suction not only through the mill, but also from this air duct. Directly above the discharge from the primary fan and connected to it by a short adapter duct was the motor-driven distributor. This consisted of three parts, the distributor body, distributor head and the distributor rotor. The secondary air was supplied by a steam-engine-driven blower.

Power Consumed by Mill and Auxiliaries

The three motors, coal feed, primary air fan and distributor, had watt-hour meters wired in their circuits so that the power requirements for these parts of the apparatus could be ascertained separately.

The mill proper being turbine driven, careful record of its speed (pinion) and the steam pressure was kept, and after completion of the run the pinion was disconnected from the gear, a Prony-brake equipment was installed, and the power taken by the turbine was ascertained under identical speeds and steam pressures as existed during the run.

The power taken by the coal-feed motor was less at the higher rates than at the lower. This was due to the fact that during the lower rates the feeder was run at higher speeds than during the higher rates. During the lower rates the position of the feeder knife was much nearer the edge of the disk than was the case during the higher rates, when the disk was rotated much more slowly, but with the knife set at a much deeper angle.

During the run at the 2,000 lb. rate trouble was experienced with the bearings of the primary air fan, making it impossible to maintain the air pressures previously found desirable, and therefore the results of this part of the run were not so good.

The most serious trouble was experienced because of moisture in the coal, which was stored out of doors and which became thoroughly wet on several occasions. Under these conditions the coal fed to the mill was so wet at times that water ran from the weighing bin and actually dripped from the feeder disk. An analysis of the coal on one occasion showed 18 per cent moisture. The mill continued to pulverize under these conditions, but the output was greatly diminished and the coal stream to the burners was extremely lean. There was, however, sufficient coal to keep the burners lighted except for one or two very brief periods, during which the oil burners were lighted. The total of these interruptions was so small that it can safely be forgotten so far as concerns results, as the total oil used was less than 25 pounds.

The results obtained on the 240-hour run, averaged for each of the 48-hour periods, or each of the five different rates of combustion maintained, are given in the table.

Attention is called to the heat release values obtained, as listed under "hourly rate of fuel fired per cubic foot of

RESULTS ON 240-HOUR TEST OF PULVERIZED COAL WITH SCOTCH MARINE BOILER, AT THE FUEL OIL TEST PLANT, PHILADELPHIA NAVY YARD

Type of Boiler:
Three furnace, separate combustion chambers Scotch marine boiler.
Type of Pulverizer:
Air-swept Kennedy tube mill.
Type of Burner:
Peabody turbulent combined coal and oil burner.
Heating Surface of Boiler:

Square feet heating surface, tubes	2,015
Square feet heating surface, combustion chambers	270
Square feet heating surface, furnaces	270
Total	2,555

Air Heater:
Type—waste heat tubular.
Sq. ft. heating surface, 638.
*Combustion Space.**

Cu. ft., furnaces	199.18
Cu. ft., combustion chambers	270.79
Total	469.97

Coal:
Bituminous, run of mine, Cambria County, Pa.

Test division number	I	II	III	IV	V
Duration, hours	48	48	48	48	48
Hourly rate—fuel fired per cu. ft. combustion space, lb.	2.57	2.94	3.40	3.83	4.20
Hourly rate—fuel fired per cu. ft. combustion space B.t.u. content	37,162	42,057	48,878	55,841	59,984
Hourly rate—fuel fired per sq. ft. heating surface, lb.	.471	.541	.626	.705	.773

* *Note*: The total volume of combustion space of the bare boiler was 482.89; of this, however, 12.92 cu. ft. taken up by a refractory ring at mouth of each furnace.

Coal Analysis—Proximate

	I	II	III	IV	V
Moisture, per cent	2.1	2.9	2.6	2.4	2.8
Fixed carbon, per cent	72.1	70.9	71.7	72.2	70.0
Volatile, per cent	20.1	20.1	20.0	20.4	21.1
Ash, per cent	5.7	6.1	5.7	5.0	6.1
Heat value, B.t.u.	14,460	14,305	14,376	14,580	14,282

Ash and Refuse Data

Total weight ash in fuel fired, lb.	3,298	4,050	4,376	4,321	5,783
Fusion temperature of ash—average for 240-hr. run	2,370 deg. F.				
Combustible in ash and flue dust, for 240-hr. run	35 (approximate) per cent				
Non-combustible in ash and flue dust	65 (approximate) per cent				
Heat value of ash and flue dust	5,180 B.t.u.				

Gas Data

Pressures, inches of water:					
CO_2 in smokebox, per cent average	16.18	16.71	17.01	17.10	16.26
Oxygen in smokebox, per cent average	2.65	1.97	1.72	1.57	2.78
CO in smokebox, per cent average	0.005	0	0.037	0.079	0.013
Temperatures (Deg. F.)					
Gas leaving boiler—average	501	551	599	628	640
Gas leaving air heater—average	415	452	502	532	538
Primary Air Discharge from Fan:					
Inches of water	1.60	1.63	1.97	2.19	2.2
Temperatures Primary Air (deg. F.)					
Feeder end of mill	145	134	132	133	108
Inlet to fan	150	142	142	147	148
At distributor	144	147	140	140	138
Secondary Air Double Front:					
Inches of water	0.53	....	.....	1.03	1.23
Temperatures (deg. F.)					
Dry bulb before air heater	89	88	86	80	75
Air ducts leaving heater	197	199	202	201	198
Air burner	214	217	215	211	206
Total weight of air per lb. of fired fuel, lb.	12.44	11.90	11.73	11.79	12.15
Excess air, per cent	14.36	10.28	8.99	7.87	15.62
KW. per Hour:					
Primary air fan	2.11	2.24	2.37	2.26	2.90
Coal feed	0.15	0.19	0.13	0.12	0.07
Distributor	0.31	0.30	0.33	0.33	0.21
Pulverizer	18.00	18.00	18.00	18.00	18.00
Total	20.57	20.73	20.83	20.71	21.18

Steam and Water Data

Boiler pressure absolute, lb. per sq. in.	190.3	190.0	190.8	191.5	192.1
Temperature water to boiler, deg. F.	208	209	211	207	210
Temperature steam in calorimeter, deg. F.	307.6	307.8	307.8	308.2	308.7
Moisture in steam, per cent	0.20	0.19	0.19	0.18	0.16

Evaporation Data

Actual evaporation per sq.ft. heating surface	5.01	5.86	6.61	7.38	7.63
Equivalent evaporation per sq.ft. heating surface	5.26	6.15	6.93	7.77	7.99

Economic Results

Actual evaporation per lb. fuel fired, lb.	10.61	10.81	10.54	10.46	9.86
Equivalent evaporation per lb. fuel fired, lb.	11.16	11.36	11.07	11.02	10.34
Equivalent evaporation per lb. dry coal fired	11.41	11.61	11.37	11.30	10.65

Heat Balance

(Based on lb. of coal as fired)

Heat absorbed by boiler, per cent	74.89	77.06	74.72	73.35	70.26
Loss due to moisture in fuel, per cent	0.17	0.24	0.22	0.21	0.25
Loss due to burning hydrogen, per cent	3.62	3.64	3.78	3.71	3.85
Loss carried away in dry gases, per cent	6.95	7.53	8.43	9.10	9.84
Loss due to carbon monoxide, per cent	0.02	0	0.18	0.26	0.04
Loss in combustion in ash and flue dust, per cent	7.45	6.43	7.22	8.57	11.16
Loss unaccounted for, radiation, etc., per cent	6.90	6.10	5.45	4.80	4.60
Fuel as fired, B.t.u. per lb.	14,460	14,305	14,376	14,580	14,282

combustion space, B.t.u. content." The values obtained on this test are unique not only in marine practice but also in stationary practice, as it will be noted that a rate of 59,984 B.t.u. was maintained during the last 48-hour period. This high heat release was accomplished by flame turbulence and high percentage of superfines in the pulverized coal.

The greater part of the ash left the boiler and went out of the stack in the form of fly ash. The deposit in the furnaces and smokeboxes was made up chiefly of the larger particles, not only of ash but also of coke. Along with the fly ash that went up the stack, there was a certain amount of fly coke that had a relatively high heat content.

Unfortunately, a continuous service test, such as the 240-hour pulverized-fuel test described herein, has not been made with oil fuel on this boiler, and so a direct comparison is impossible. However, several oil burners have been tested on this same boiler, the efficiency curves of these burners being determined from two-hour peak periods during the day's run.

It is felt, therefore, in order to make a comparison between the results obtained with pulverized fuel and those obtained with fuel oil, that the peak periods of the 240-hour test should be used for determining the pulverized coal characteristic efficiency curve.

As there is a difference in the heat content of coal and oil, the comparison between the two fuels must be based on some factor other than weight. The factors selected were boiler efficiency plotted against equivalent evaporation per square foot of heating surface. Of the five commercial burners plotted only one shows an efficiency rate in excess of the pulverized coal for evaporation less that 7.5 lb. per sq.ft. of heating surface.

Reclaiming Waste Heat in a Dyehouse*

THE problem of supplying a dyehouse with an ample quantity of hot water at all times is one that deserves more thought than is usually given to it. The fuel cost of large volumes of hot water is an important item, particularly where steam is purchased at relatively high cost, when it is several times what the actual fuel cost would be if the mill operated its own boiler plant.

In view of this high cost of steam the management of one plant recently decided that heat must be conserved, and they accordingly decided to put in a waste-heat recovery system that would conserve a large percentage of the heat in the waste liquor from the vats.

The diagram shows the principle adopted, which is briefly as follows:

All the dye tubs are so arranged that they can be dumped into either of two launders, one being the cold waste launder and the other the hot launder. All the neutral hot waste liquor runs from the hot launder into a concrete basin holding about 6,000 gal., and in this basin is a vertical-shaft motor-driven centrifugal pump with float control. As soon as the level rises in this receiving basin, the pump starts up and elevates the waste liquor into the 5,000-gal. wood storage tank. The waste water flows from this tank through a strainer and through a Griscom-Russell multiwhirl heat exchanger, and from this exchanger into the cold launder, and then to waste. To avoid possibility of corrosion in the heat exchanger, any hot waste liquor that contains any quantity of acid or alkali is thrown into the cold launder, but this represents only a small percentage of the total hot waste.

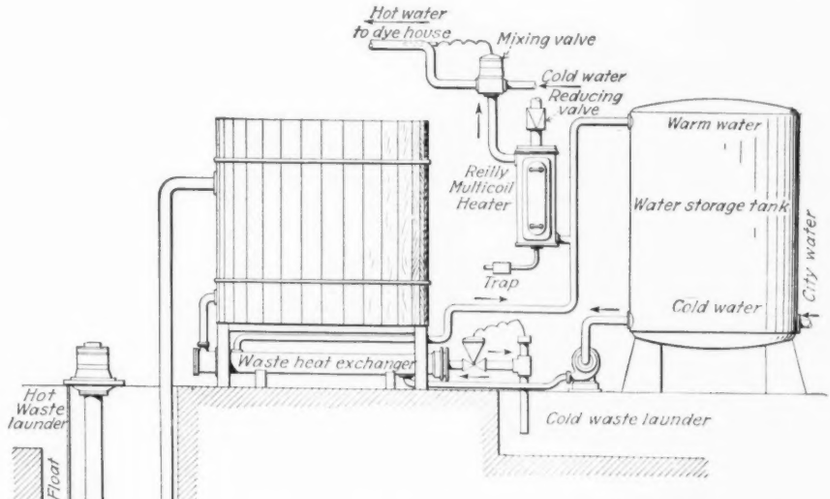
The fresh water system consists of a 3,500-gal. vertical, cylindrical steel pressure tank, which is filled with water under city pressure. A small motor-driven centrifugal pump draws the water from the bottom of this tank, pumps it through the shell of the heat exchanger and back to the top of the tank. This is a continuous operation, and as the flow from the wood waste tank is also continuous, from 75 to 80 per cent of the heat in the waste water is continually transmitted to the fresh water in the storage tank and is saved.

A Griscom-Russell Reilly heater is installed and connected into the outlet of the heat exchanger, and this heater is large enough to supply the instantaneous demand for hot water when dye tubs require filling. By carrying 10 to 15 lb. steam pressure in the shell of this heater, water at 215 to 220 deg. F. is obtained, and this passes through a thermostatically controlled mixing valve and is tempered to the desired temperature, generally about 160 deg. F. This temperature is maintained within two or three degrees, plus or minus.

It is of interest to mention, in passing, that the steel tank never contains water over about 130 to 140 deg. F., which is the maximum temperature to which the waste-heat exchanger can heat the water, and that this tank is protected against pitting and corrosion by a series of cement washes, so that the water is never in contact with the actual metal of the tank. This, together with the relatively low temperature of the water, will undoubtedly preserve the tank for many years.

Eventual Capacity 10,000 Gal. Per Hour

The plant is designed for an eventual capacity of 10,000 gal. of waste water per hour. The average temperature of this water is 175 deg. F. and the average reduction in temperature is to about 90 deg. F., so that 85 deg. are removed and conserved from 10,000 gal. per hour of waste water. This represents 7,038,315 B.t.u. per hour. At the price of steam as purchased by the mill, one million B.t.u. is worth, in round figures, $1, which, of course, is several times the actual fuel cost where steam is taken from a boiler plant owned and operated by the mill. The waste-heat saving, therefore, will eventually be about $7 per hour, and on a 2500-hour mill year this represents $17,500 per annum of heat saved, which in most dyehouses goes direct to the sewer without any attempt at recovery.



Layout of waste-heat recovery and hot-water supply system for a dyehouse

The system has been in operation long enough to demonstrate that no operating difficulties will be encountered. The tubular heat exchanger does not clog up, nor is there any evidence of corrosion. The hot water supply is ample and immediate at all times, and the system is entirely automatic and requires no attendance.

*Abstracted from an article in *American Wool & Cotton Reporter*, Nov. 17, 1927.

RECENT PUBLICATIONS

PROCEEDINGS OF THE NATIONAL DISTRICT HEATING ASSOCIATION FOR 1927. Published by the Association. Cloth, 6x9 in.; 452 pages.

THE proceedings of the eighteenth annual convention of the N. D. H. A., held at West Baden Springs Hotel, May 17-20, 1927, is officially reported in this publication. It contains the papers presented at the convention, together with the discussion, reports of committees and addresses.

HEATING AND VENTILATION. By Dr. H. Riestschel and C. W. Brabbee. Published by the McGraw-Hill Book Company, Inc. Cloth, 6x9 in.; 332 pages, illustrated. Price, $4.50.

THIS text is a translation of the seventh German edition of Rietschel-Brabbee "Heizungs-and Luftungstechnik," and is intended to make European viewpoints available to American architects and engineers. The text is divided into four parts, and in addition there are included 38 pages of engineering data and seven charts for shortening the work incident to the design of heating and ventilating system. A general discussion of various methods of heating is given in Part I. This section also includes a more detailed description of various types of hot water and steam systems. Part II deals with ventilation, the reasons for it, number of air changes required, and ventilation methods. A chapter is also devoted to methods of cooling rooms. A more detailed discussion of the factors entering the design of heating and ventilating systems is given in Parts III and IV. The methods of design are illustrated with solutions to practical design problems.

BOILER FEED WATER PURIFICATION. By Sheppard T. Powell, consulting chemical engineer. Published, 1927, by McGraw-Hill Book Company, Inc. Cloth; 6x9 in.; 363 pages; 150 illustrations; 24 tables; 8 plates. Price, $4 postpaid.

THIS book fills a great practical need. Corrosion and scale in boilers are among the most pressing problems encountered by the power-plant operator, particularly in industrial plants with high percentages of makeup. Strangely enough, no books treating the subject adequately have been available up to the present. To meet the pressing need for practical guidance in handling feed-water problems, Mr. Powell, at the request of the Editor, prepared a series of articles on the subject for publication in *Power*. These appeared during 1926 and aroused much reader interest. These articles, rewritten and considerably expanded, are incorporated in the present book.

Mr. Powell combines extensive chemical engineering experience with practical knowledge of boiler-room problems. His book is free from ultra-technical discussions and well adapted to the every-day needs of designers and operators who know but little chemistry. The following subjects are treated in the fifteen chapters:

Natural waters and their impurities; removal of suspended solids by plain subsidence; chemical coagulation; Filtration; water softening by chemicals; water softening by Zeolites; evaporation; deaëration; deconcentration and continuous blowdown; boiler compounds, priming and foaming; corrosion—its cause and cure; embrittlement of boiler metal; feed-water heaters and miscellaneous treatment; standard methods of water analysis. An appendix gives useful tables and definitions, maps, operating log forms, etc.

A.S.T.M. TENTATIVE STANDARDS, 1927. Published by American Society for Testing Materials, Philadelphia, Pa. 824 pages. Price, $7.

THE 1927 compilation of tentative standards of the A.S.T.M., covering 175 items in effect up to Sept. 1, 1927, contains much to which power engineers should give attention. These tentative standards are issued by the society in order that engineers may suggest revisions before the standards are finally adopted. It will be helpful to the society in its work and to the engineering profession as a whole, if any criticism of these tentative standards that may come up are given speedily, so that final standards may be arrived at with the least delay.

Of particular interest to power engineers are the following: A 114-27 T, specifications for marine boiler steel plate; A 95-26 T, specifications for carbon-steel castings for valves, flanges and fittings for high-temperature service; A 105-27 T, specifications for forged or rolled steel pipe flanges for high-temperature service; A 106-27 T, specifications for lap-welded and seamless steel pipe for high-temperature service; B 61-26 T, specifications for steam or valve bronze sand castings.

Another group of important tentative standards deals with refractories and includes: C 64-27 T, specifications for clay firebrick for stationary boiler service; C 65-27 T, specifications for clay firebrick for marine boiler service; C 38-27 T, test for resistance of fireclay brick to thermal spalling action; C 71-27 T, definitions of terms relating to refractories.

Other important standards include: D 197-26 T, test for fineness of powdered coal; D 271-27 T, methods for the determination of sulphur in coal and coke; D 121-27 T, definitions of terms relating to coal and coke; D 54-24 T, specifications for steam hose; D 119-27 T, specifications for rubber insulating tape.

It is important for the society and for those affected by its standards that all who can help in turning these tentative standards into final, accepted standards, study the specifications here mentioned and give the society the benefit of their suggestions without delay.

OPPORTUNITIES FOR THE SCIENTIFIC REFRIGERATION ENGINEER is the title of a booklet issued recently by the Siebel Institute of Technology, of Chicago, outlining its latest extension course in refrigeration engineering. The course is divided into twenty lessons containing the complete text material to be studied. Each lesson contains an examination of about ten questions, bearing on every-day problems occurring in the shop or plant. The twenty lessons are subdivided into four groups, the first being of a preparatory nature and taking up in five lessons a general review, both historical and statistical, of refrigeration engineering, its scope and application; the subjects of heat and heat transfer, engineering quantities and the properties of gases. In the second group are given the processes of refrigeration. The lessons of the third group treat on the construction and operation of the various machines and apparatus used in refrigeration plants. In the fourth group the student takes up the proper application of refrigeration, such as ice-making in general, applications of refrigeration, installation of systems, codes, maintenance, troubles and remedies, and data on economies to be obtained. In other words, the student is carried through the entire field of refrigeration, presented for the most part from the practical point of view, with a preliminary study of fundamentals that will be of use to him in the later lessons of the course.

PRESS BULLETIN SERIES NO. 12, ILLINOIS PETROLEUM, will soon be issued from the press by the State Geological Survey at Urbana, Illinois. It discusses the question of deeper production in the Allendale oil field. Descriptions of a number of wells drilled recently in the area are given along with the correlation of the sands penetrated with the sands in Lawrence County and adjacent portions of Indiana. From these data conclusions as to the proper areas for deep testing in the Allendale field are drawn. The paper also includes a structure map, graphic logs, and several tabulated logs. As long as copies are available, they may be procured for 25 cents by addressing a request to the Chief, State Geological Survey, Urbana, Ill.

NEWS *of the* FIELD

Engineers Join in Celebrating Fiftieth Birthday of Philadelphia Club

Prominent Men Honor Half-Century Mark in Two-Day Session—Review Past and Present of Profession and Future Aspects—Recall Club's History

THE Engineers Club of Philadelphia was fifty years old on Dec. 17. Fitting observance of the occasion was a program covering several sessions, a luncheon, a banquet, and entertainment at the Bellevue-Stratford, during which the past, present and future in engineering were discussed by leaders in the several branches of the profession.

"Engineering Fifty Years Ago" was the topic assigned to the first session held on Friday evening, the two speakers being Ambrose Swasey, past-president of the American Society of Mechanical Engineers, and Willard T. Chevalier, representing the American Society of Civil Engineers.

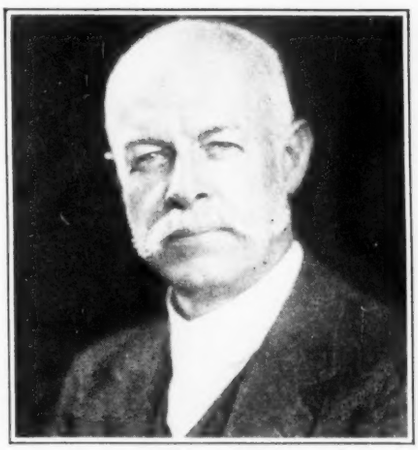
At the Centennial Exposition

Mr. Swasey took the audience back to the days of the Centennial Exposition of 1876 and described the big Corliss engine which was the marvel of the exposition. This engine, which was of 1,400-hp. and weighed 700 tons, he contrasted with the modern airplane engine of one-third the power and weighing only 1½ pounds per horsepower. The Porter-Allen engine and the contributions by the late Professor Sweet were also touched upon by the speaker in referring to that period as the "Age of Steam."

At the time of the exposition the electric light was in its infancy as was the telephone, the air brake and the phonograph. Moreover, John Fritz had just installed the first open-hearth furnace at Bethlehem. These beginnings, as well as others mentioned by Mr. Swasey, had developed during the last fifty years into vast industries that have totally changed our mode of living.

Colonel Chevalier discussed the broader aspects of engineering rather than the purely technical side. Characterizing engineering as "science applied to economic and social ends," he discussed the rôle of the engineer in modern civilization. The ancients enjoyed comforts because of their slaves, but now that mechanical power has replaced human slavery, the few no longer have this advantage at the expense of the many; hence, a new order of things pertains for which the engineer has been largely responsible.

Likening prosperity to a three-legged stool, dependent upon research, production and merchandising, the speaker showed how production of new products, resulting from research, had absorbed a large part of the excess labor made available through increased use of mechanical power. Merchandising had absorbed the rest and had done much to educate the mass of the people in desires for these new products. There was no likelihood of the American public being oversold as the only limit to production is what we can earn.



Charles E. Billin
Secretary of the Club, and One of Its Founders

With reference to administration Colonel Chevalier saw danger in placing too much importance on organization, which should be regarded only as a framework, with individual human effort as the all-important factor.

In the realm of finance, conditions have changed to a marked degree. Excepting a very small class of parasitic individuals almost everyone is now contributing to the national wealth and higher standard of living. Ownership is widespread and there has been a distinct change in corporate viewpoint.

The remainder of the evening was devoted to music and a buffet supper.

At a special convocation at the University of Pennsylvania, Saturday forenoon, honorary doctors degrees were conferred upon Messrs. Howard Elliott, Chairman of the Board, Northern Pacific Railway; John Hays Hammond, the well-known mining engineer; and Charles M. Schwab. A luncheon followed at the Bellevue, at which addresses were made by Mr. Schwab, Mr. Elliott and Dr. Frank B. Jewett.

Mr. Schwab, in his characteristic way made a plea for more sentiment in business. "The real man," he said, is the one who retains the confidence and affection of those associated with him."

Increased Output per Worker

Mr. Elliott, dealing with engineering of the present, reviewed the contributions of the engineer to the present industrial age and quoted figures from the U. S. Census to show the increase in output per worker. Sixty-seven men are now producing what 100 did in 1899. This has brought about a higher standard of living, more men entering the profession, and more time for enjoying the luxuries resulting from greater production. He told of the important work in research and standardization being carried out at the Bureau of Standards at an annual expenditure of two million dollars which it is estimated results in a net saving to industry of one hundred million.

Referring to the railway field, Mr. Elliott said that six billion dollars has been expended in improvements since 1920; that the situation is improving and that revenues are now approaching a fair return, the average being 5.13 per cent. He believed the engineer should have a greater voice in the regulation of public utilities.

Future of Engineering

At the banquet on Saturday evening, attended by over four hundred, J. H. M. Andrews, president of the Club, reviewed its early history and growth from 60 to 1,700 members, and on behalf of the trustees conferred honorary membership upon the secretary, Charles E. Billin, who was one of the founders. Three other original members of the Club, Messrs. Roberts, Lewis and Webster, were present.

"The Future of Engineering" was the topic of the evening, covered by Samuel Rea, past-president of the Pennsylvania, and Dexter S. Kimball, president, American Engineering Council.

Mr. Rea prophesied that the next fifty years would witness marked strides in the conservation of natural resources, particularly coal, which would be distilled. No raw coal would be used directly and all household and industrial

heating would be by gas. He saw extension of mine-mouth power plants, greater use of electricity, the increase of agricultural products through scientific discoveries and the production of more synthetic products through chemical development. The railroads he believed would continue to dominate freight and passenger service, although airplanes would find a place in high-speed de luxe passenger travel and for certain classes of express service. For long-haul trunk lines the steam locomotive would hold its own, improved through the use of higher pressures and attainment of greater efficiency.

One of the most acute problems of the next fifty years, in Mr. Rea's opinion, will be highway situation to accommodate the ever increasing automobile traffic. Double- and perhaps triple-decked arteries would likely be one of the means employed.

CITES LAW OF DIMINISHING RETURNS

Dean Kimball thought that the field of agriculture preventive medicine and engineering had contributed most to our present progress. The increasing use of power he believed one of the greatest factors. As an example of the American habit of doing things in a big way he cited the growth in size of turbine units from 5,000-kw. in 1903 to the 208,000-kw. units that are on order for State Line Station. He cautioned, however, that we cannot escape the fundamental law of diminishing returns by which the marginal gains decrease to the point that it no longer pays, from an economic standpoint, to attempt further gain. In the field of industry the speaker believed that, although there had been large improvements in management, further gains would be made. Business is beginning to have a new idea of economics, and industry, under private ownership and control, will ultimately exist for the support of the human race rather than for corporate gain. High wages have gone hand-in-hand with increased production and have effected large savings in cutting down labor turn-over. This fact was first demonstrated by Henry Ford. Moreover, installment buying has been accompanied by increased savings bank accounts.

Engineering methods of analysis are being employed more and more, and one of the problems of the next fifty years is to bring expert knowledge to bear on public questions. For illustration Dean Kimball cited the mess that Congress has made of Muscle Shoals and the Farmers' bill.

Siebel Institute Opens Western Coast Branch

The Siebel Institute of Technology, Chicago, has established a branch in San Francisco to be known as the western division under the charge of Benno Lowy, chemical engineer.

The branch includes both laboratory and educational division. To insure rapid service, samples of raw materials and those relating to production control for clients in this territory may be submitted directly to the Western Division, Siebel Institute of Technology, 417 Montgomery St., San Francisco, Calif. Attention, Benno Lowy, director.

Report Ready on Power Stage Sites on Eel River, Calif.

The geology of the Mill Creek and Elk Creek dam sites and the Round Valley reservoir site on the Middle Fork of Eel River, Mendocino County, Calif., is set forth in a report prepared by the Geological Survey, Department of the Interior. An engineering examination of Eel River made in 1922 by the Geological Survey disclosed that its value for power was largely dependent upon the feasibility of storing the flood waters in or near Round Valley. The most promising sites for dams were found short distances below the mouths of Mill Creek and Elk Creek.

The report has not been published, but a manuscript copy may be examined at the office of the Geological Survey in Washington, D. C., or at the district office of the Geological Survey, Custom House, San Francisco.

Ammonia Compressor Explodes, Damaging Syracuse Plant

Extensive damage was sustained by the explosion of an ammonia compressor in the Central City Cold Storage and Arctic Companies' plant at Syracuse, N. Y., Dec. 12. The cause of the explosion has not been determined. It occurred in a ton and a half machine on the ground floor of the building. It was blown from its base and toppled over on one side. Several persons in homes in the immediate vicinity of the plant were overcome by the escaping gas and had to be rescued. It was more than an hour, according to report, before the flow of gas on the main tank could be shut off, which was finally accomplished by the efforts of the engineer of the plant. He mounted a ladder and climbed to the ceiling of the gas-filled room where the valve was located.

The loss to the plant was estimated at $15,000.

Plans for Missouri Plant

Plans for building a central power station in northeast Missouri, near Moberly, with an initial capacity of 5,000 kw., which will later be increased, were announced recently by the Missouri Power & Light Company.

Senate Votes Down Walsh Power Inquiry to Interstate Commerce Committee

Repels Senator's Resolution, Adopting Moses' Motion by Decision of 40 to 36—Supporters of Inquiry See Delay of Many Weeks, If Not Burial

BY A VOTE of 40 to 36 Senator Thomas J. Walsh, of Montana, suffered a signal setback on the floor of the Senate, Dec. 19, in his efforts to push his "power trust" resolution to an immediate acceptance.

Contrary to the expectations of the supporters of the resolution, which calls for a thorough investigation of alleged power combines, the Senate by a majority of four votes turned down the suggested measure, and adopted the motion of Senator George H. Moses to refer it to the Interstate Commerce Committee, Senator Watson, of Indiana, chairman.

Effect of this action will be at least to delay the resolution for weeks and in the opinion of some Senators it will be to bottle it up indefinitely and hold it back for the whole session. Senator Wheeler, of Montana, in fact, speaking for the resolution on the floor, predicted that if the resolution went to the Interstate Commerce Committee it would not be reported.

Senator Walsh and other friends of the resolution, by speeches on the floor and otherwise, will seek to force the resolution out of the committee at an early date. Nevertheless it is obvious today's outcome was a victory for the opponents of the proposed power inquiry. The result came as a surprise in most quarters, as it had been supposed the resolution would pass.

When Senator Walsh called up his resolution and moved passage, Senator Moses promptly moved reference to the Interstate Commerce Committee.

Senator Walsh objected that "there was no occasion for this, that the Senate had had the resolution before it for six or seven months and fully understood it." He called attention to some of the salient facts about power matters, to which he also had directed attention last session. He spoke of the "enormous capital going annually into public utilities and power projects and into securities of these concerns and of holding companies." He declared the mergers now being made "are giving rise to great concern," presented data from the *Electrical World* to show the magnitude of the business and declared the companies engaged in it "are passing into the control of a half dozen new holding companies."

A number of Senators were drawn into the debate which followed.

American Institute of Electrical Engineers Nominate Officers for 1928

Choose R. F. Schuchardt, Commonwealth Edison, Chicago Engineer, for President—Name Also Vice-Presidents, Managers and Treasurer

R. F. SCHUCHARDT, electrical engineer with the Commonwealth Edison Company, Chicago, has been nominated for president of the American Institute of Electrical Engineers. Mr. Schuchardt will take the helm of the society Aug. 1, when the rest of the candidates assume the duties of the offices then fallen vacant.

These candidates, selected by the national nominating committee, consisting of fifteen members from various sections of the country, are:

For vice-presidents, Northeastern district, E. B. Merriam, executive engineer, switchboard department, General Electric Company; New York City District, H. A. Kidder, superintendent of motive power, Interborough Rapid Transit Company, New York City; Great Lakes District, W. T. Ryan, professor of electrical power engineering, University of Minnesota, Minneapolis; Southwest District, B. D. Hull, engineer, Southwestern Bell Telephone Company, Dallas, Tex.; Northwest District, G. E. Quinan, chief electrical engineer, Puget Sound Power & Light Company, Seattle; for managers, A. E. Bettis, vice-president, Kansas City Power & Light Company, Kansas City, Mo.; J. Allen Johnson, electrical engineer, Niagara Falls Power Company, Niagara Falls, N. Y., A. M. MacCutcheon, engineering vice-president, Reliance Electric & Engineering Company, Cleveland, and for treasurer, George A. Hamilton, electrical engineer (retired), Elizabeth, N. J.

Mr. Schuchardt's Activities

These official candidates, together with any independent nominees that may be proposed later, will be voted upon by the membership at the coming election in the spring of 1928.

Rudolph Frederick Schuchardt was born in Milwaukee, Wis., Dec. 14, 1875. He was graduated from the University of Wisconsin with the degree of B. S. in electrical engineering in June, 1897. During the first year after his graduation he was employed by the Janesville (Wis.) Electric Light & Power Company as general utility man, and later by Meysenburg & Badt, Chicago, as engineering salesman. Since July 1, 1898, he has been with the Chicago Edison Company and its successor, the Commonwealth Edison Company. In November, 1906, Mr. Schuchardt was appointed engineer of electrical construction, and in 1916 he was appointed electrical engineer of the company, which position he still holds.

Mr. Schuchardt was elected an associate of the Institute in 1903 and was advanced to the grade of member in 1909 and to the grade of Fellow in 1912. He was a vice-president of the Institute for the years 1922-1924. His committee activities have been as follows: Chairman of power generation committee 1921-22; and member at various times of the education, power generation, protective devices, standards power transmission and distribution, meetings and papers, executive, electrical machinery, and law committees. He is still a member of the law committee.

Rudolph F. Schuchardt

Some of his other society memberships include Institution of Electrical Engineers (Great Britain), Western Society of Engineers, Illuminating Engineering Society, and National Electric Light Association.

Three Terms Restrict Sale of Muscle Shoals

Three principles under which the disposition of the Muscle Shoals project will be considered were announced by the House Committee on Military Affairs, Dec. 20. These terms are:

"One—That property shall at all times be subject to the absolute right and control of the government for nitrates or other components of munitions of war, and that nitrate plant No. 2 (or its equivalent, or such other nitrogen fixation plant or plants adjacent or near thereto as may be constructed) must be kept available therefor by the purchasers, lessees, or users of the property;

"Two—That the purchasers, lessees, or users of the property shall be obligated in the strictest terms to the manufacture and sale to the public of fertilizers in time of peace.

"Three—That any proposal for the purchase, lease, or use of the Muscle Shoals property of the United States Government must be for the entire property."

Eight Power Projects Are Planned in Oregon

Applications for eight power projects in Oregon have been filed with the Federal Power Commission.

M. L. Vorse has applied for a preliminary permit for construction of a power project on Hood River, Eagle Creek and Wahtum and Lost Lakes in Hood River County, about 45 miles from Portland, proposing to construct three dams, and a power house near Cascade Locks. The power, when developed, will be used for manufacture of wood pulp.

The Deschutes Falls Power Company has applied for a preliminary permit for the construction of a dam, reservoir, conduit and power house on the Deschutes River, in Sherman and Wasco Counties. It is the intention to use the power to be developed from this construction for public utility purposes.

J. G. Kelley has applied for a preliminary permit to construct a project designed to include a diversion dam, conduit, power house and transmission line. The completed project will have a power capacity of 15,000 hp. and will be situated on Marion Lake and the north fork of Santiam River, in Marion and Linn Counties, near Detroit. The power proposed to be developed will be used for public utility purposes.

A dam and power house of 1,300 hp. capacity to be located on Loon Lake and Mill Creek, tributaries of the Umpqua River, near Reedsport, Douglas County, will also be constructed. The power proposed to be developed will be used for public utility purposes.

The city of Eugene has applied for a preliminary permit for the construction of three power developments on the McKenzie River, in Lane County.

British Capital in Electricity

About $4,000,000,000 is invested in the British electrical industry, according to an analysis of official statistics reported to the United States Department of Commerce by the office of the American Consul General at London. Capital invested in the British electrical industry has increased during the last year by more than $225,000,000, subscribed in 1,633 undertakings in all branches of the industry.

Recent Diesel Engine Installations

A number of Diesel engine installations of interest in Western and Southwestern States and by the United States Shipping Board have recently been reported.

Plans for the conversion of three cargo boats, the "Triumph," "Courageous" and "Defiance," have been completed by the Gibbs Brothers, Inc., for the United States Shipping Board. All three boats are now equipped with geared-turbine, single-screw drive, and this will be superseded with modern Diesel-electric drive. The "Courageous" will be converted by the Federal Shipbuilding Company, the "Triumph," by the Boston Navy Yard, and the "Defiance," by the Norfolk Navy Yard.

Four 1,280-hp., 250-r.p.m., four-cycle, air-injection Diesel engines will be supplied by the McIntosh & Seymour Company for each vessel. Each engine will be direct connected to two General Electric 375-volt d.c. generators; one of 800 kw. will supply power for propulsion and the other, a 150-kw. excitation, auxiliary power and lighting.

Two 840-hp. Diesels have been purchased by the Insull interests from Fairbanks, Morse & Company for installation in one of th Insull Texas public utilities.

Six 600-hp. Diesel engines, built by the Busch-Sulzer Diesel Engine Company, St. Louis, Mo., have been ordered by the Humble Oil Company, to be utilized for pumping purposes at the Corpus Christi, Tex., ship loading station.

Murray Iron Works Acquires Standard Turbine Corp.

Steam turbines have been added to the line of the Murray Iron Works, products, Burlington, Iowa, through acquisition of the Standard Turbine Corporation plant at Scio, N. Y. Equipment of that plant is being shipped to the Burlington unit, which has been enlarged for the new department.

A. Y. Dahlstrand formerly of the Standard Turbine Corporation plant will direct new turbine production unit. The Murray Iron Works now produces Corliss engines, boilers and foundry equipment. George G. Higbee is president of the company, which was established in Burlington shortly after the Civil war and has been in continuous operation since.

Power Project Is Planned on Eleven Point River, Mo.

A declaration of intention to establish a power project on Eleven Point River in Oregon Co., Mo., has been filed by Jess Priest and W. H. Williams of Poplar Bluff, Mo., the Federal Power Commission stated Dec. 19.

It is proposed to build a dam 60 ft. high across the river to insure a reservoir capacity of 870,000,000 cu.ft. The primary capacity was estimated at 2,856 horsepower.

Senate Committee Schedules Boulder Dam Hearings

Hearings on the Boulder Dam project in the House will begin Jan. 6 and will be concluded on Jan. 14, Representative Addison T. Smith, of Twin Falls, Idaho, chairman of the House Committee on Irrigation and Reclamation, announced Dec. 20.

The Committee will give consideration to the program provided in the legislation sponsored by Representative Philip D. Swing, of El Centro, Calif., who has reintroduced the bill which was passed by the House in the last session but failed to receive action in the Senate.

Senate hearings on Colorado River bills, it was also announced by the Senate Committee on Irrigation and Reclamation, will begin Jan. 17 and continue for a week. The Senate Committee will consider a measure drafted by Senator Johnson, of California, which is identical with the Swing bill, and also a program advanced by Senator Phipps, of Colorado, chairman of the Senate Committee.

The Governor of Utah, George H. Dern, chairman of the Council of the States of the Colorado watershed, will be a witness at the House Committee hearings.

Record Production of Electricity by Public Utilities Reached in October

DURING the month of October 6,904,000,000 kw.-hr. of electricity was produced by public-utility power plants for public use, according to figures compiled by the Geological Survey of the Department of the Interior. This is the largest output of electricity ever produced in a single month. It is equivalent to an average production of 222,700,000 kw.-hr. per day and is about one per cent more than the revised figures of average daily output for September.

Reports are received from plants representing over 95 per cent of the total capacity. The output of those plants which do not submit reports is estimated; therefore the figures of output and fuel consumption as reported in the accompanying tables are on a 100 per cent basis.

Division and State	By Water Power, 1927			By Fuels, 1927			Total, 1927		
	August	September	October	August	September	October	August	September	October
United States	2,404,210	2,199,792	2,375,527	4,280,224	4,400,384	4,528,735	6,684,434	6,600,176	6,904,262
New England	143,426	135,531	171,655	301,203	311,950	306,528	444,629	447,481	478,183
Middle Atlantic	444,970	437,671	507,235	1,270,994	1,270,044	1,367,866	1,715,964	1,707,715	1,857,101
East North Central	160,098	151,750	197,383	1,364,565	1,374,078	1,412,850	1,524,663	1,525,828	1,610,233
West North Central	135,715	130,579	147,592	273,770	289,780	284,743	409,485	420,359	432,335
South Atlantic	195,240	150,764	180,661	517,956	548,666	533,128	713,196	699,430	713,789
East South Central	184,145	153,452	140,836	118,866	159,012	172,147	303,011	312,464	312,983
West South Central	2,465	2,272	2,435	291,945	292,847	294,104	294,410	295,119	296,539
Mountain	279,454	258,602	242,343	34,631	37,890	38,455	314,085	296,492	280,798
Pacific	858,697	779,171	785,387	106,294	116,117	118,914	964,991	895,288	904,301

The figures in the table below show that the gain in the monthly output over 1926 has gradually decreased from May to October, and that there has been a decided increase in the daily output for each month from July to October, which compares favorably with the average for the last seven years. The increase in the output by the use of water power indicates that the streams have passed the period of low water.

TOTAL MONTHLY PRODUCTION IN 1926 AND 1927

	1926	1927	Per Cent Increase, 1927	Produced by Water Power (per Cent) 1926	1927
January	6,150,000,000	6,730,000,000	9	32	35
February	5,629,000,000	6,080,000,000	8	34	36
March	6,178,000,000	6,717,000,000	9	37	38
April	5,812,000,000	6,416,000,000	10	40	40
May	5,849,000,000	6,582,000,000	12	40	41
June	5,920,000,000	6,475,000,000	9	38	39
July	5,955,000,000	6,455,000,000	8	34	38
August	6,175,000,000	6,684,000,000	8	34	36
September	6,221,000,000	6,600,000,000	6	33	33
October	6,594,000,000	6,904,000,000	5	33	34
November	6,482,000,000		..	35	..
December	6,817,000,000		..	35	..
	73,791,000,000			35	

The quantities given in the first table are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations and electric-railway plants.

Standards Committee Send Out Hydraulic Symbols Proposal

Recently the American Engineering Standards Committee issued a proposal of tentative American standards symbols for hydraulics. These were prepared by the sub-committee on symbols for hydraulics and the sectional committee on scientific and engineering symbols and abbreviations. The proposed standard is now being distributed for criticism and comment. Suggestions and changes should be addressed to Preston S. Miller, Secretary, Sectional Committee on Scientific and Engineering Symbols and Abbreviations, 80th St. and East End Ave., New York City.

Decision to undertake the standardization of scientific and engineering symbols and abbreviations as a national enterprise was made at a general conference called by the American Engineering Standards Committee and held in the rooms of the American Society of Mechanical Engineers Feb. 13, 1923. Three organizations the American Institute of Electrical Engineers, the Association of Edison Illuminating Companies and the American Society of Mechanical Engineers made the original recommendations which resulted in the calling of this conference.

Official representatives of national organizations attended this conference, and after a full discussion voted that this project should be undertaken, and that the American Association for the Advancement of Science, the National Research Council, the Society for Promotion of Engineering Education and the United States Bureau of Standards should be requested to accept joint sponsorship. Later the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society of Civil Engineers were invited to become joint sponsors.

Two Colorado Water Power Units Near Completion

Work on two units of the Lake Spaulding system of power generating plants at Emigrant Gap, Placer, Co., Colo., is nearing completion, and the third, Spaulding No. 3, will probably start early in the Spring. The Spaulding units No. 1 and No. 2, are being reconstructed from established plants. They are near Smart. No. 3 will be on the rim of the lake.

The Spaulding No. 1 plant is on the almost perpendicular side of the Bear River Canyon, below the Lake Spaulding Dam. This plant, which is being rebuilt to include a 10,700-hp. unit, utilizes the water discharged from Lake Spaulding.

The No. 2 plant is on the canyon side, below the No. 1 plant. Water is dropped through a pipe line to this plant operating a 5,000-hp. unit, which will be semi-automatic in operation.

The new No. 3 plant will be located on the rim of the lake one and a half miles from the No. 1 plant, which will become the control, or operating plant. To provide for additional facilities and the housing of switchboards and control apparatus, a two-story structure will be built on the face of the canyon, adjoining the present No. 1 plant.

Welding Topic at Boston Societies Meeting

Practical applications of arc welding was the general topic of discussion at the all-day meeting of the Affiliated Technical Societies of Boston, attended by a large number of interested engineers, Dec. 14.

Welding as applied to building construction was the element featured at the sessions. Gilbert D. Fish, consulting structural engineer of the Westinghouse Electric & Manufacturing Company, spoke on the favorable aspects of the process.

Power Project Planned in British Columbia

Construction of a new dam and power house on the Shuswap River, B. C., by the West Canadian Hydro-Electric Corporation, Vancouver, will begin immediately following the expiration of the time limit and the granting of water rights on Shuswap River. Announcement to this effect was made by George J. Burdick, engineer for the Vancouver firm, who will supervise operations.

The power house will be made large enough to house another unit, present development plans calling for 4,200 hp. Work will be carried on throughout the winter and will be completed in time to deliver power by Oct 1, 1928, as agreed.

Obituary

GEORGE A. CARPENTER, past president of the Providence Engineering Society, Providence, R. I., and city engineer of Pawtucket for the past 36 years, died Dec. 15, after an illness of ten days. Mr. Carpenter was at the time of his death president of the New England Water Works Association.

Personal Mention

CHARLES E. BECK, formerly sales engineer for the De La Vergne Machine Company, Kansas City, Mo., will be connected with the Busch-Sulzer Diesel Engine Company Jan. 1.

U. S. BARRETTA, test engineer with the Detroit Edison Company, has been promoted to boiler room engineer.

HAROLD A. THOMAS, professor of hydraulics at the Carnegie Institute of Technology, has been appointed hydraulic engineer for the City of Pittsburgh.

OTTO V. KORIES, member of the A.S.M.E., formerly sales engineer with Garvey & Palmer, Pacific Coast distributors of the Foos Engine Company, Los Angeles, has accepted a position as chief engineer with the Holtville Ice & Cold Storage Company, Holtville, Calif.

VAN CORTRIGHT MEKEEL, formerly connected with Taylor-Wharton Iron & Steel Company, High Bridge, N. J., in capacities of mechanical engineer, special research investigator, and sales engineer, has resigned to accept a post as special representative of The Nugent Steel Castings Company, Chicago.

DEAN DEXTER S. KIMBALL has been appointed by Secretary Hoover as a permanent member of the Committee of the World's Congress of Engineers. Dean Kimball is a past-president of the American Society of Mechanical Engineers and is president of the American Engineering Council.

R. TURNWALD, widely known designer of uniflow steam engines, formerly of the Stumpf Uniflow Engine Co., Syracuse, N. Y., has joined the Worthington Pump & Machinery Corp., Cincinnati, Ohio. Mr. Turnwald has been associated also with the Ames Iron Works Company, Oswego, N. Y. and the Chuse Engine, Matoon, Ill.

W. NELSON SMITH, who was for some years connected with the Winnipeg Electric Company as consulting electrical engineer, and returned to the United States about a year ago, has recently become associated with the organization of E. L. Phillips & Company, engineers at 50 Church St., New York City, and will continue in public utility engineering.

JAMES CHARLES BENNETT, comptroller and secretary of the Westinghouse Electric & Manufacturing Company, was recently elected a vice-president. In his new position he will have general charge of the accounting and treasury departments. In length of service Mr. Bennett is one of the oldest employees in the Westinghouse Electric group, he having been employed by the Westinghouse Electric Company in 1886 five months after that company was formed.

PROF. VLADIMIR KARAPETOFF, member of the A.I.E.E. has been voted the award of the Elliott Cresson Gold Medal by the Franklin Institute, "in consideration of the inventive ability, skill in design, and detailed theoretical knowl-

edge of kinematics and electrical engineering displayed in the development of computing devices." This medal will be presented May 16, when all awards made during the Institute year will be presented.

L. O. HASSLER, of the Beaumont Manufacturing Company, Philadelphia, and formerly chief engineer, has been transferred to the Western headquarters in the Strauss Building, Chicago, where he will devote himself to sales in the Chicago territory under the direction of H. C. Birch.

PROF. ROBERT T. HASLAM, of the Department of Chemical Engineering of the Massachusetts Institute of Technology, has resigned from the faculty. He will continue his connection with the Institute as non-resident professor, but will devote practically his entire time to development work relating to the oil industry as a member of the executive staff of the Standard Oil Development Co., at 26 Broadway, New York City.

I. F. BAKER has been promoted to manager of the Far Eastern department of the Westinghouse International Company, with offices in New York. He comes to his new position from Japan, where he was managing director of the Westinghouse Electric Company of Japan for several years. In 1918 he was made a commercial engineer in the Westinghouse Electric International Company of New York, and in 1919 was sent to Tokio, Japan, as a manager. Six years later he was promoted to managing director.

CHARLES H. BROMLEY, member of the A.S.M.E., formerly manager for the S. F. Bowser Company, and at one time for eseveral years on the staff of *Power*, has joined the France Packing Company, Tacony, Philadelphia, becoming vice-president. Mr. Bromley will participate largely in the management of sales and the shops, devoting particular attention to research in the further adaptation of France metallic floating packing for high pressures and temperatures. Mr. Bromley joined *Power* in 1915. He left the paper early in 1921.

Business Notes

THE PRAT-DANIEL CORPORATION, manufacturers of the Thermix air heater and stream-line stacks, announce that W. H. Caldwell has become associated with them for the handling of sales in New York City and the surrounding territory.

THE BEAUMONT MANUFACTURING COMPANY Philadelphia announces that William P. Alexander who resigned from that organization in May is returning to the company's sales department and, as formerly, will devote himself to sales duties in the Philadelphia, Baltimore, and Washington districts.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Engineering Council, annual meeting will be held in Washington, D. C., Jan. 9-11; L. W. Wallace, executive secretary, 26 Jackson Place, N. W., Washington, D. C.

American Institute of Electrical Engineers, winter convention at New York City, Feb. 13-17, F. Hutchinson, secretary, 29 West 39th St., New York City; St. Louis Regional Meeting, District No. 7, March 7-9; Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Society of Heating & Ventilating Engineers, hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Mechanical Engineers, Spring Meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

THE ROLLWAY BEARING COMPANY, Syracuse, N. Y., has opened a sales office at 614 Empire Building, Pittsburgh, Pa. Samuel Farrell, who has been affiliated with the Rollway Bearing Company, Inc., for a number of years, with headquarters at Youngstown, Ohio, is now also in charge of the Pittsburgh office.

Society Affairs

A. S. M. E. BUFFALO: January 17, Hotel Statler at 8:00 p.m. Subject: "The Arteries of Industry," motion picture films, National Tube Co. W. P. Wooldridge will lecture. There will also be shown a film on building New York's newest subway by the Dupont Company.

A.I.E.E., CLEVELAND SECTION meeting at Hotel Statler, 8 o'clock, Jan. 19; "Today's Science, Tomorrow's Engineering," by L. A. Hawkins, General Electric Company.

A.I.E.E., NEW YORK SECTION meeting at 29 West 39th St., New York City, Jan. 13, "Interconnection of Power Systems," Alex Dow, president of Detroit Edison Company, and Farley Osgood, consulting engineer.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Dec. 22, 1927
Navy Standard	New York	$2.25@$2.75
Kanawha	Hampton Roads	4.15@ 4.40
Smokless	Cincinnati	2.25@ 2.50
Smokless	Chicago	2.25@ 2.50
S. E. Kentucky	Chicago	1.40@ 1.60
Steam	Pittsburgh	1.60@ 1.90
Gas Slack	Pittsburgh	1.15
Big Seam	Birmingham	2.00@ 2.25
Anthracite (Gross Tons)		
Buckwheat	New York	$2.65@$3.35
Birdseye	New York	1.60@ 1.85

FUEL OIL

New York—Dec. 22, light oil, tank-car lots, 26 deg. Baumé, 5c. per gal.; 28 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Dec. 12, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.48c. per gal.; 38@40 deg., 5.24c. per gal.

Pittsburgh — Dec. 19, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia — Dec. 15, 26@30 deg., $1.60@$1.66 per bbl.; 13@19 deg., $1.47 @$1.53 per bbl.; 22 plus, $1.63@$1.69 per bbl.; 27@30, $2.10@$2.16 per bbl.

Cincinnati—Dec. 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Dec. 17, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Dec. 19, tank-car lots, f.o.b., 12@14 deg. Baumé, 4½c. per gal.; 28@ 32 deg., 5¾c. per gal.

Dallas—Dec. 17, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Trade Catalogs

ENGINE TYPE DIRECT CURRENT MACHINES—Allis-Chalmers Manufacturing Company describes these machines in illustrated, new Bulletin No. 1142.

PUMPS—In Bulletin 209 the Pennsylvania Pump & Compressor Company describes the construction and operation of its line of double-suction single-stage pumps.

HEATERS, COOLERS, CONDENSERS AND EXCHANGES—The O. E. Franks Heater & Engineering Company, Inc., Buffalo, N. Y., treats in an illustrated bulletin, No. 50, such heating equipment. Tables of dimensions and capacities are given.

ARCHES AND WALLS—The M. H. Ditrick Company has issued a ninth edition of a publication the purpose of which is to show the application of Ditrick arches and walls to every type of furnace burning every class of fuel. This is accomplished in 63 pages of illustrating in detail the furnace wall and arch construction used in various installations.

SECTIONAL AIR HEATERS—The Foster Wheeler Corporation, general offices at 165 Broadway, New York City, discusses the use of preheated air and its history in Bulletin A.H.-7, which is devoted to description and illustration of sectional air heaters manufactured by the company. This heater is constructed on a design comprising the multiple use of standard sections, which can be arranged in series or parallel flows for either gas or air, but all connections are standard and all joints match exactly. So, interchangeability is afforded.

TURBINE BLOWERS — Wing turbine blowers, for furnishing forced draft to both stokered and hand-fired boilers, are described and illustrated in a new bulletin recently published by the L. J. Wing Manufacturing Company, 352 West 13th St., New York City. Diagrams and photographs of actual installations are pictured, and tables of capacities, dimensions, and other engineering data are included. The number of the bulletin is 87. The function of Wing blowers in boiler plant operation, their results and advantages claimed are discussed in another booklet, No. 700.

STEAM PURIFICATION—Bulletin 677, published by the Cochrane Corporation, describes some of the results that may result from the use of wet and contaminated steam. It gives the causes of steam contamination, and describes the Cochrane purifier for removing moisture and solid matter. It also includes some interesting instruction on methods of steam calorimetry.

WATER COOLED FURNACES—The Erie City Iron Works has printed "Some Fundamentals of Water Cooled Furnace Design," written by Prof. W. J. Wohlenberg, which gives a clear, concise understanding of the use of the outstanding types of water-cooled furnaces. Charts, data and illustrations combine to make this authoritative article of value to the engineer interested in getting the most out of pulverized coal. "The Erie City Vortex Furnace" is the title of a leaflet which describes briefly a method of firing small water-tube boilers and horizontal return tubular boilers with pulverized coal.

NEW PLANT CONSTRUCTION

Ala., Alabama City — Gulf States Steel Co. awarded contract for the construction of a power plant to Dwight P. Robinson & Co., Inc., 129 East 46th St., New York, N. Y. Estimated cost $3,000,000.

Ala., Montgomery — Capitol City Hotel Co., J. D. Scruggs, Pres., awarded contract for a 12 story hotel to Hugger Bros. Construction Co. Esitmated cost $1,000,000.

Colo., Devine—Colorado Interstate Gas Co. controlled by Prairie Oil & Gas Co., Amarillo, Tex., is having plans prepared for a booster compressing station on natural pipe line here. Estimated cost $700,000. Ford, Bacon & Davis, 115 Broadway, New York, N. Y., are engineers.

Calif., Los Angeles — Firestone Tire & Rubber Co., South Main St., Akron, O., is receiving bids for first unit of factory, including 103 x 113 ft. power house, etc., at Manchester Ave. and Alameda St., here. Estimated cost $1,000,000. Total cost $7,000,000. Curlett & Beelman, 120 Union Bank Bldg., Los Angeles, Calif., are architects.

Calif., San Francisco — One Thousand Seventy Six Chestnut Inc., E. B. DeSurville, 110 Sutter St., awarded contract for a 14 story apartment building on Chestnut St. to Dinwiddie Construction Co., Crooker Bldg. Estimated cost $750,000.

Ill., Belleville—Hotel Belleville Co., H. W. Houck, Pres., will receive bids about Jan. 10 for a 6 story hotel including steam heating system, etc., at Illinois Ave. and Public Sq. Estimated cost $550,000. J. L. Bowling, Inc., 1198 Arcade Bldg., St. Louis, Mo., is architect. P. E. Corrubia, 815 Holland Bldg., St. Louis, Mo., is associate architect.

Ill., Chicago—A. S. Alschuler, 28 East Jackson Blvd., Archt., is receiving bids for the construction of apartment building and post office at 5440 West Madison St., for Jacob Kulp & Co., 19 South La Salle St. Estimated cost $500,000.

Ill., Chicago—Two Hundred Twenty-Two East Chestnut St. Building Corp., c/o Rissman & Hirschfeld, 228 North La Salle St., Archts., is having plans prepared for a 19 story apartment building at Chestnut and DeWitt Sts. Estimated cost $2,250,000.

Ill. Columbia—City plans an election Jan. 10 to vote $28,000 bonds for waterworks improvements including pumping equipment, tank on tower, etc. Total estimated cost $75,000. W. A. Fuller Co., 1912 Railway Exchange Bldg., St. Louis, Mo., is engineer.

Ill., Solon Mills—Wilson Sand & Gravel Co., F. N. Wilson, Prop., has work under way on the construction of a new plant to include 150 hp. boilers or Diesel engines. Private plans.

Ind., Anderson — C. G. Wolf, Wheeling, W. Va., V. U. Young, Gary, Ind. and G. C. Hallis, Muncie, Ind., plan the construction of a 7 story hotel and theatre building at 12th and Meridian Sts. here. Estimated cost $750,000. A. M. Strause, 706 Tri-State Bldg., Fort Wayne, Ind., is architect.

Ind., Indianapolis — Methodist Hospital, 16th and Capitol Sts. is having plans prepared for a 16 story hospital. Estimated cost $650,000. D. A. Bohlen & Son, Majestic Bldg., are architects.

Kan., Manhattan—Kansas State Agricultural College, H. E Schrack, Bus. Mgr., will soon award contract for the construction of a power plant. Estimated cost $325,000. C. D. Cuthbert, State House, Topeka, is architect.

Md., Baltimore—Gillet Realty Corp., c/o Wyatt & Nolting, Keyser Bldg., Archts., awarded contract for a 12 story apartment building at 3908 Charles St. to Consolidated Engineering Co., 20 East Franklin St. Estimated cost $1,000,000. Vapor or vapor vacuum heating system, elevators, etc., will be installed.

Mass., Boston—Dept. of Public Buildings is having sketches made for the construction of a power house and heating plant on Charles St. Estimated cost $100,000.

Mass., Boston—Penal Institutions Dept. will soon award contract for the construction of a power house on Deer Island, Boston Harbor. J. H. Ritchie & Associates, 250 Stuart St., Boston, are architects.

Mich., Detroit — S. Plotkin, Lafayette Bldg., awarded contract for an 11 story hotel on East Jefferson Ave. to Otto Misch Co., 159 East Columbia Ave. Steam heating and refrigeration systems, boilers, elevators, etc., will be installed.

Mich., Eloise — Wayne County, Superintendents of Poor, County Bldg., Detroit, will soon award contract for a 4 story hospital including steam heating and ventilation systems, boilers, elevators, etc., on Michigan Ave., here. Estimated cost $500,000. Maul & Lentz, David Whitney Bldg., Detroit, are architects.

Mo., Kansas City—Coronado Hotel Co., 308 Curtiss Bldg., is having preliminary plans prepared for an 8 story hotel at Thirty-third and Main Sts. Defoe & Beseckes, 114 West 10th St., are architects.

Mo., St. Louis—Benjamin Anschl, c/o B. Leland & Co., 4101 Lindell Blvd., is having preliminary plans prepared for a 12 story apartment building including vapor heating and electric refrigeration systems, etc., at Lindell Blvd. and Sarah St. Estimated cost $1,000,000. J. L. Bowling, 1198 Arcade Bldg., is architect.

N. J., Bayonne — F. L. Mongiello, 74 West 23rd St., will build an ice plant at 78-84 West 23rd St. Estimated cost $40,000. C. S. Goldberg, 437 Broadway, is architect. Work will be done by separate contracts.

N. J., Jersey City—Universal Securities Co., H. W. Runyon, Pres., 50 Journal Sq., is having plans prepared for a 17 story hotel including steam heating and ventilation systems, boilers, elevators, etc., at 2861-2867 Hudson Blvd. Estimated cost $5,000,000. T. Martin & J. Kilpatrick, 220 South 16th St., Philadelphia, Pa., are architects.

New York—International Paper Co., New York, has work under way on the construction of a hydro-electric development at Kent's Falls. Plans include the initial installation of two 4,000 hp. generators and one to be installed later.

N. Y., Bedford Hills—Montefiore Home, awarded contract for five hospital buildings to Cuzzi Bros., 10 South 2nd Ave., Yonkers. Estimated total cost, $600,000.

N. Y., Brooklyn—S. Wander, (Promont Realty Co.) 50 East 42nd St., will build a 15 story apartment building at Montgomery St. and Prospect Pl. Estimated cost $600,000. E. Roth, 1440 Broadway, New York, is architect. Work will be done by separate contracts.

N. Y., New York—Courtlef Realty Corp., A. E. Lefcourt, Pres., 1351 Broadway, will build a 26 story office building at 263 7th Ave. Estimated cost $3,500,000. Buchman & Kahn, 49 West 45th St., are architects. Work will be done by separate contracts.

N. Y., New York—Ellbar Realty Co., 16 East 42nd St., plans the construction of a 14 story apartment building at 83rd St. and Park Ave. Estimated cost $1,200,000. Architect and engineer not selected.

N. Y., New York—Orion Buliding Corp., 300 Madison Ave., had plans prepared for a 9 story office building at 201 East 35th St. Estimated cost $500,000. Gronenberg & Leuchtag, 1385 Broadway, are architects.

N. Y., New York—Park Avenue-Thirty-Ninth St. Corp. plans the construction of a 31 story hotel at 39th St. and Park Ave. Estimated cost $3,000,000. W. Rouse, 512 5th Ave., is architect. Work will be done by separate contract under the supervision of Shroder & Koppel, 420 Lexington Ave.

N. Y., New York—Realty Trust Co., 509 5th Ave., will build a 20 story office building at 14th St. and Broadway. Estimated cost $1,750,000. E. Roth, 1440 Broadway, is architect. Work will be done by separate contracts.

N. Y., New York—Two Hundred Twenty-Nine East Seventy Ninth St. Corp., B. M. House, Pres., 17 West 96th St., had plans prepared for a 15 story loft and store building at East 79th St. and Second Ave. Estimated cost $1,000,000. Ellis, Aaronson & Heidrich, 25 West 43rd St., are architects. Work will be done by separate contracts.

N. Y., Rochester—L. Brotsky, 425 Hollenbock St., is having plans prepared for a 4 story apartment building on East Ave. Estimated cost $500,000. W. J. Fuehrer, 205 Clifford Ave., is architect.

O., Kent—Bd. of Trustees, Kent Normal School, plans remodeling power house. Estimated cost $35,000.

O., Yellow Springs—Bd. of Trustees of Public Affairs, C. H. Ellis, Clk., will receive bids until Jan. 11 for the construction of a waterworks system including pump house, etc. Jennings-Lawrence Co., Hartman Bldg., Columbus, is engineer.

Okla., Tulsa—A. E. Aaronson, Court Arcade Bldg., plans the construction of a 10 story apartment building including steam heating system, elevators, etc., at 9th and Boulder Sts. Estimated cost $600,000. A. H. Gentry, 438 Dwight Bldg., Kansas City, Mo., is architect.

Pa., Philadelphia — R. J. Seltzer, 15th and Locust Sts., awarded contract for a 21 story apartment at 13th and Chancellor Sts., to F. V. Warren Co., 1913 Arch St.

Tex., Brownsville — Texas Citrus Fruit Growers Assn., c/o J. O. Shary, Pres., Mission, plans the construction of a packing plant here. Estimated cost $60,000. Complete machinery and equipment will be required.

Tex., Corpus Christi — Smith Bros. & Nixon & Associates awarded contract for a 10 story hotel to McKenzie Construction Co., Travis Bldg., San Antonio. Estimated cost $600,000. Steam heating, ventilation and refrigeration systems, boilers, elevators, etc., will be installed.

Tex., Edcouch—Central Power & Light Co., c/o Frost Bldg., San Antonio, will build a 58 x 102 ft. power plant, here. Estimated cost $80,000. J. W. Walter is chief engineer.

Tex., Fort Davis—Central Power & Light Co., Frost Bldg., San Antonio, will build a power plant by day labor. Estimated cost $60,000. Private plans.

Tex., Fort Worth — Montgomery-Ward Co., Chicago Ave. and Larr St., Chicago, Ill., will receive bids until Jan. 22 for an 8 story jobbing building at Camp Bowie Blvd., between Carrol St. and Fresco tracks. Estimated cost $2,000,000. Private plans.

Tex., Laredo—John Armengol, plans to develop 1,000 acres of land for citrus irrigation to include pumping unit, etc. Private plans.

Tex., Nocona — Texas-Louisiana Power Co., H. A. Thompson, Dist. Mgr., will build a 150 x 250 ft. power plant by day labor. Estimated cost $325,000. Private plans.

Tex., San Antonio — Texas Ice House, Inc., c/o A. J. Zilker, is having plans prepared for the construction of an ice plant on Fredericksburg Rd. Estimated cost $60,000. Private plans.

Vt., Bennington — Twin State Gas & Electric Co., 510 Main St., awarded contract for a power plant, here, also one at Hoosick Falls, N. Y., to Morton C. Tuttle Co., Park Sq. Bldg., Boston, Mass.

Vt., Mendon — Vermont Hydro Electric Corp., Center St., awarded contract for the construction of a hydro-electric plant, to Morton C. Tuttle Co., Park Sq. Bldg., Boston, Mass.

Ont., St. Marys — St. Marys Wood Specialty Co., W. James, Mgr., plans the construction of a new power plant. Estimated cost $15,000.

Ont., Toronto—Farmers Dairy Co., Walmer Rd., is having plans prepared for the construction of a dairy including cold storage plant, etc., on Danforth Ave. Estimated cost $150,000. Roper Gouinlock, 371 Bay St., is architect.

Ont., Toronto—King-Adelaide Corp., c/o H. F. Williams, King Edward Hotel, awarded contract for two 28 and one 14 story office buildings at Jordan St. between Adelaide and King Sts., to W. H. Yates Construction Co., 95 King St. E. Estimated cost $30,000,000.

Ont., Toronto—Star Publishing Co., 70 King St. W., will soon award contract for superstructure of a 22 story newspaper office and plant including elevators, etc. Estimated cost $3,000,000. Chapman & Oxley, Northern Ontario Bldg., are architects.

Ont., Windsor—Greater Windsor Development Co., c/o Trace & Diehl, 23 West Pitt St., Archts., is having plans prepared for a 25 story hotel including steam heating, refrigeration and ventilation systems, boilers, elevators, etc., on London St. Estimated cost $1,500,000.

Sask., Estevan—Northern Light & Power Co., Bismarck, N. D., plans the construction of a power plant here. Estimated cost $5,000,000.

T. H., Honolulu — Dillingham Co., c/o Walker & Eisen, Western Pacific Bldg., Los Angeles, Calif., Archts., is having preliminary plans prepared for a 4 story store building here. Estimated cost $1,250,000

Equipment Wanted

Boilers, Stokers, Conveyors, Pump, etc.—Bd. of Trustees of Kent Normal School, Kent, O., plans to purchase two 250 hp. boilers, two large stokers, conveyors, etc., for boiler room, $50,000, also one large water pump for waterworks, $9,000.

Conveying Equipment, etc.—Commercial Milling Co., 203 Randolph St., Detroit, Mich., will receive bids until Jan. 17 for elevating and conveying equipment for proposed addition to flour mill. Estimated cost $65,000.

Engines, Generators, Exciters, etc.—Bd. of Trustees, Edinburg, Ind., will receive bids unitl Dec. 29 for furnishing and installing two oil engines, generators, and exciters, together with switchboard, air compressors, oil pump, water pumps, transformers, etc., for municipal lighting plant, to cost $40,000.

Heating System—Bd. of Public Service, St. Louis, Mo., will receive bids until Jan. 17 for heating system for City Sanitarium, estimated cost $24,000.

Motors and Ventilation Equipment—Alameda County, G. A. Gross, Clk., Oakland, Calif., will receive bids until Jan. 9 for motors and ventilation equipment for Oakland-Estuary project.

Pump — Engineers Office, Washington, D. C., plans to purchase a carbon steel dredge pump complete with spare parts for dredge "Bernard" at Jacksonville, Fla.

Pumps—Bd. of Trustees of Public Affairs, C. H. Ellis, Clk., Yellow Springs, O., will receive bids until Jan. 11 for one 150 g.p.m. motor driven pump and one 150 g.p.m. gasoline driven pump for proposed waterworks improvements.

Pumping Unit—Delta Development Co., c/o E. C. Couch, Weslaco, Tex., plans the installation of a pumping unit in proposed waterworks and distribution systems. Estimated cost $30,000.

Pumping Unit—Newport Mesa Irrigation Dist., D. J. Dodge, Secy., Costa Mesa, Calif., will receive bids until Jan. 3 for furnishing and installing complete pumping unit for 12 in. well.

Pumps—Mississippi River Dredging Dist., Box 1017, Memphis, Tenn., will receive bids until Jan. 3 for one 18 and one 20 in. single suction dredging pumps.

Pumps, Engines, Filters, etc. — A. A. Snell & Associates, c/o Jordan Hotel, Marfa, Tex., prices and catalogs on pumps, engines, filters, etc., for mining and refining sodium nitrates.

Pumps and Motors—Country Club, Lincoln, Neb., is in the market for two electric pumps and motors for proposed waterworks improvements. Estimated cost $17,000.

POWER *Information Bureau*

Your machinery, equipment, and materials requirements will be noted *free of charge* in the New Plant Construction section of POWER.

Use the Coupon to make your requirements known

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Volume 66 December 27, 1927 Number 26

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BOILERS AND FURNACES

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POWER PLANT DESCRIPTIONS

Hotel Makes Good Showing in Production of Steam and Power 1006
BY E. H. FISH AND F. V. HADLEY.
IMPROVEMENTS IN PLANT result in steam cost of 51 cents per thousand pounds and power cost under 2 cents per kilowatt hour.

PUMPS AND COMPRESSORS

Propeller Pumps Proposed for Condenser Service 1002
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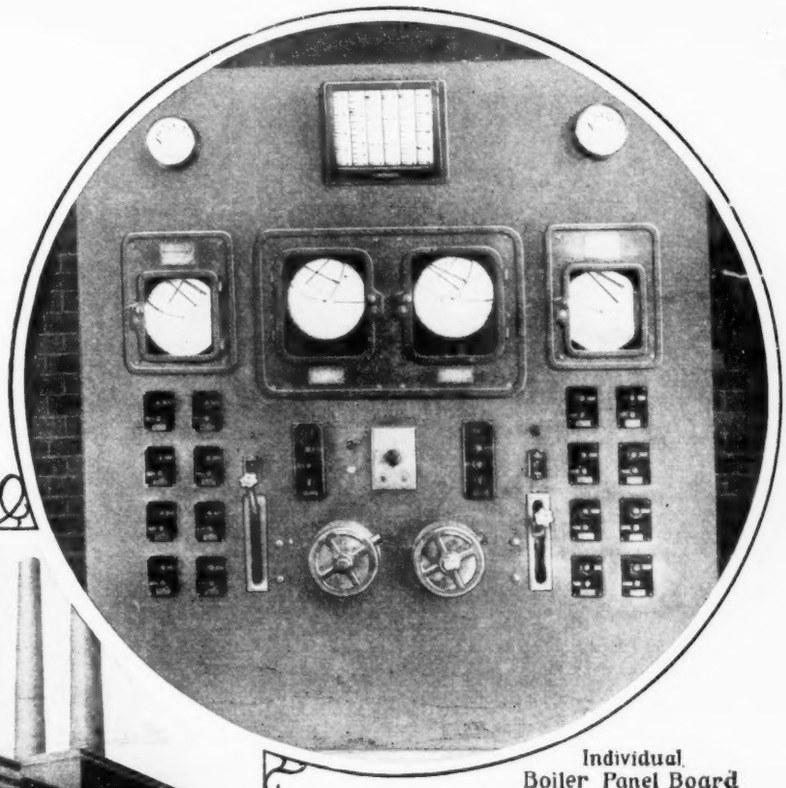
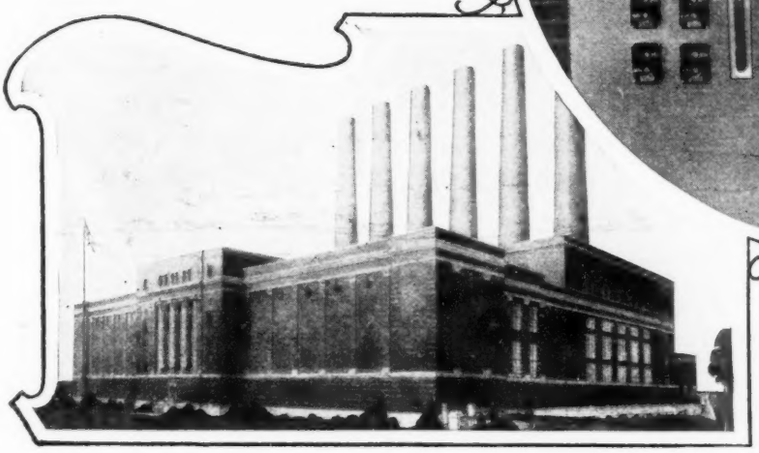
Bailey Meter Control



Individual Boiler Panel Board



Bailey Meter Control automatically regulates the supply of fuel and air to steam boiler furnaces to handle the variations in load. It controls the supply of fuel and air simultaneously in accordance with the demand for steam as indicated by changes in the steam pressure and maintains the proper proportions of air to fuel to give best combustion efficiency consistent with most economical operation.

The panel board shown above is installed on a 3060 h.p. Stirling Boiler fired with pulverized coal. The boiler has two steam outlets as well as two gas outlets, so that Bailey Totalizing Boiler Meters are used to record the total Steam Flow from the two steam lines, the Air Flow through the two sections of the boiler and the Furnace Draft. The recorders on the extreme left and right of this panel board are Bailey Temperature Recorders used for recording Flue Gas Temperatures, Superheated Steam Temperatures and Feed Water Temperatures.

The Multi-Pointer Gage at the top of the panel indicates Primary Air Pressures, Furnace Draft, Uptake Draft and Induced Draft Fan Speed.

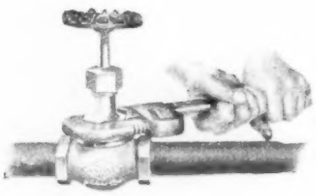
Descriptive Bulletins mailed upon request.

BAILEY METER CO.

1036 IVANHOE RD. CLEVELAND, OHIO.

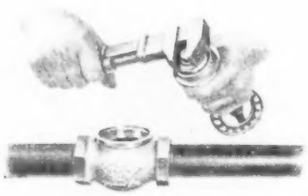
Bailey Meter Company Limited, Montreal, Quebec.

A Simple Matter



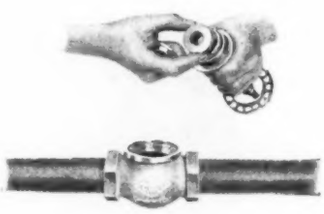
1

Apply a smooth jaw wrench to the bonnet of the valve and unscrew. The bonnet and all trimmings can be lifted from the valve, without removing body from the line.



2

Turn spindle all the way up then unscrew disc nut and remove old disc.

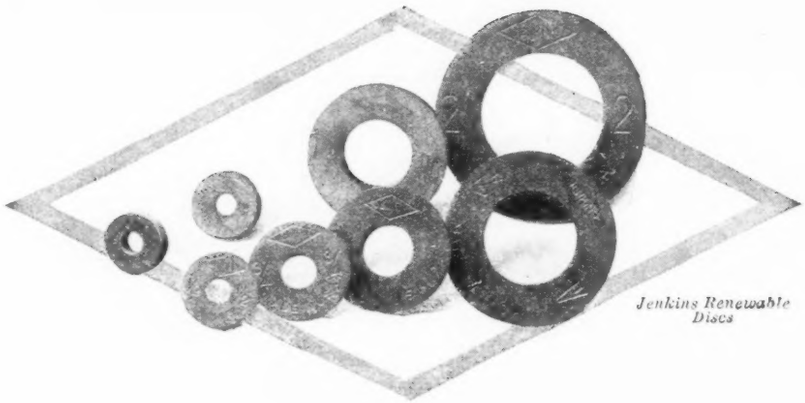


3

Insert new disc in disc holder and screw on and tighten disc nut.

4

Return the bonnet and trimmings to the body. The valve is again practically as good as new and ready for service.



Jenkins Renewable Discs

A small part of large importance

A disc is one of the smallest parts of a valve yet it is of first importance. For the disc and the seat determine the tightness of the valve itself.

With a Jenkins Disc in a Jenkins Valve you can take leak-proof contact for granted. You can be sure that the resilient disc has the additional advantage of taking up wear.

Thus a Jenkins Composition Disc prolongs the life of a valve in two ways — first by easing the strains on the wearing parts, and second by furnishing a resilient surface which adjusts itself to the valve seat always making a tight contact.

There is a wide range of compositions in which Jenkins Discs are furnished. The engineer can select a disc specially suited to the service and the pressure in which it is to be used. Send for your copy of the Jenkins Disc folder which gives the complete schedule.

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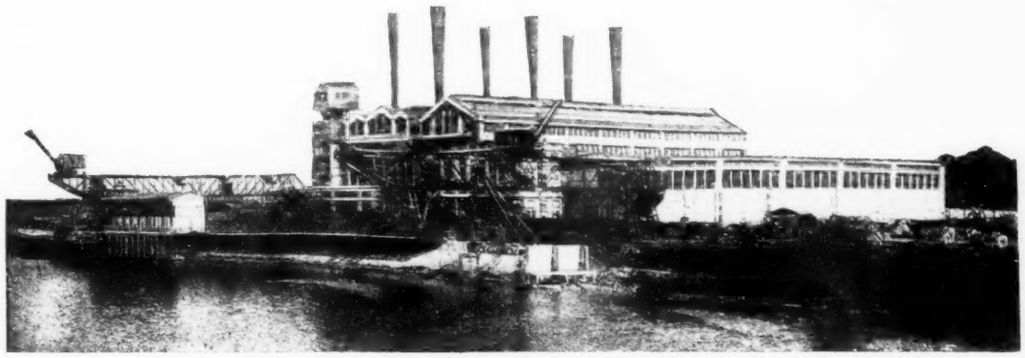
SINCE 1864

Gennevilliers Station of France now has 84 COPES Regulators



La Supercentrale de Gennevilliers, de L'Union d'Electricite

Before Colonel Mercier designed La Supercentrale de Gennevilliers, de L' Union D'Electricite—France's foremost power station—he was commissioned to inspect the finest plants in Europe and America.

As a result of what operating men in these plants told him, COPES Feed Water Regulators exclusively were specified for the original installation on 5—2260 hp. and 10—1430 hp. boilers operating at 365 lb. pressure.

The judgment of those operating men was found to be correct. Several additional units have since gone into Gennevilliers—all COPES equipped. A recent order for 8 more COPES brings the equipment at this station to a total of 84 COPES Regulators.

If you were to make a thorough survey of modern power plants in America or Europe you would receive reports similar to those given to Colonel Mercier.

Whether it be on largest boilers, highest pressure boilers, or most boilers, you would find an overwhelming preference for COPES, both in central stations and in industrial power plants.

Preferences such as that of 83% of the Prime Movers Committee of the N.E.L.A.—America's most authoritative group of operating and consulting power plant engineers—are based solely on the ability of the COPES to give an absolutely reliable and accurate regulation of feed water input.

More than 28,000 COPES Regulators are now in service. Some reasons for this are shown in "Modern Methods of Boiler Feed Water Regulation," sent on request.

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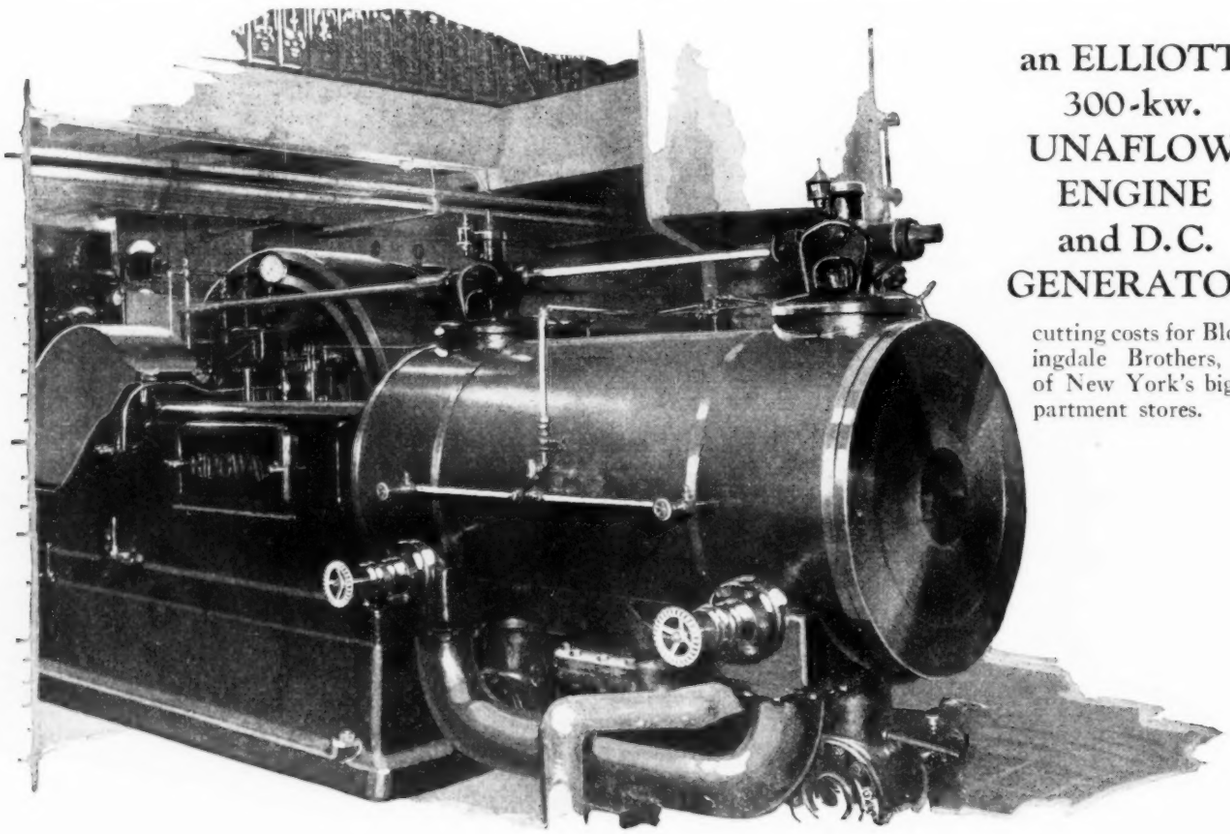
Department stores are close buyers—not only of the commodities they sell, but also of the power, light and heat they require. Bloomingdale Brothers, one of New York City's foremost department stores, is no exception to the rule.

Down in the basement of Bloomingdale's huge store, far beneath the rows of busy counters and the constant tread of countless buyers, is a quietly functioning Elliott Unaflow Engine-Generator unit. This unit supplies current for the thousands of lights which help sales, while the exhaust from the engine furnishes steam for heating the entire building. The indicated economy which caused the selection of this unit, has been fully realized in performance. Through the savings it effects, this installation is confidently expected to pay for itself inside of three years.



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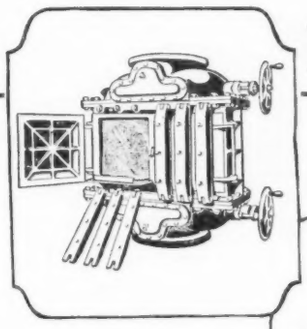
B-218

Small but essential
power plant equipment



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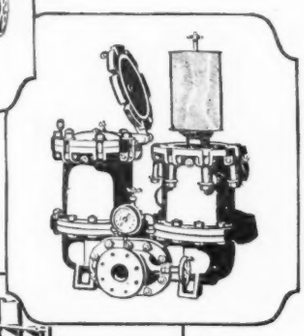

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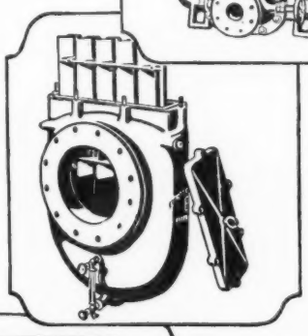

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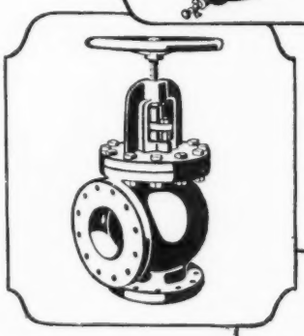
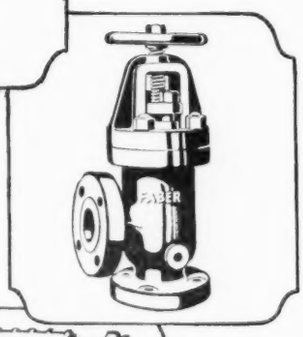
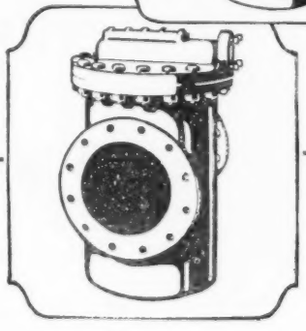


Non - Return and Automatic Valves — types for " services.



Faber Self-Cleaning Blow - Off Valve — washes its disc and seat on closing.



Elliott Desuper-Heaters — a logical, safe and automatic method for desuperheating steam.

Clearing water of solid matter and debris which would injure pumps or clog condensers—extracting oil and grease from boiler feed—protecting boilers and men when tubes fail or headers rupture—separating oil or moisture from exhaust steam effectively—taking the trouble out of blow-off valve service—desuperheating steam. Such are the essential services rendered by the Elliott products, illustrated here.

Such services are incidental but very important phases of power plant economy. It is well to know that your strainers, grease extractors, non-return valves, separators, blow-off valves, desuperheaters, etc., are of Elliott manufacture. For that means they are rugged in construction, reliable and efficient in operation, and convenient and accessible for the operator.

Bulletins fully descriptive of each of the Elliott power accessories on request.

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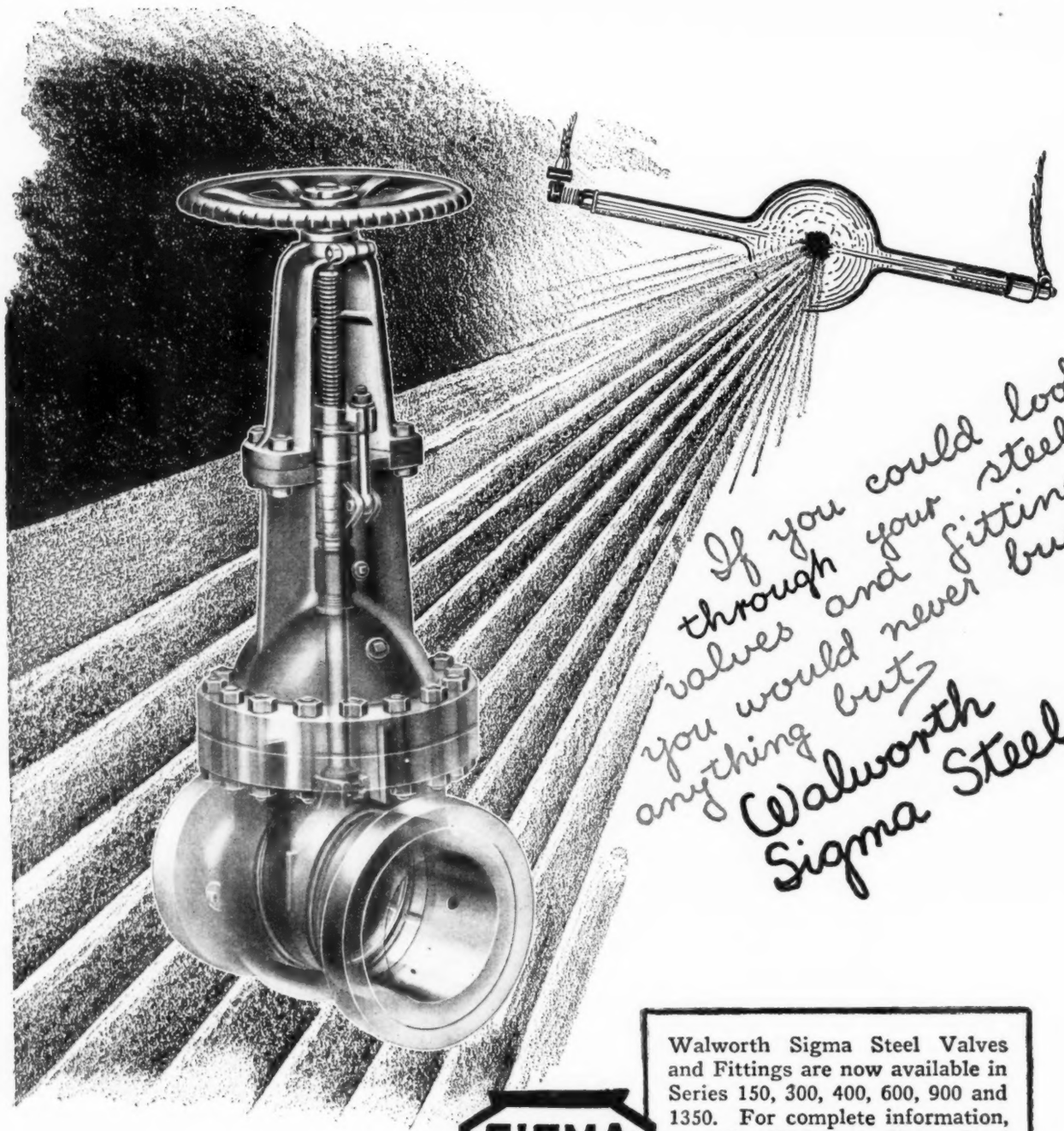

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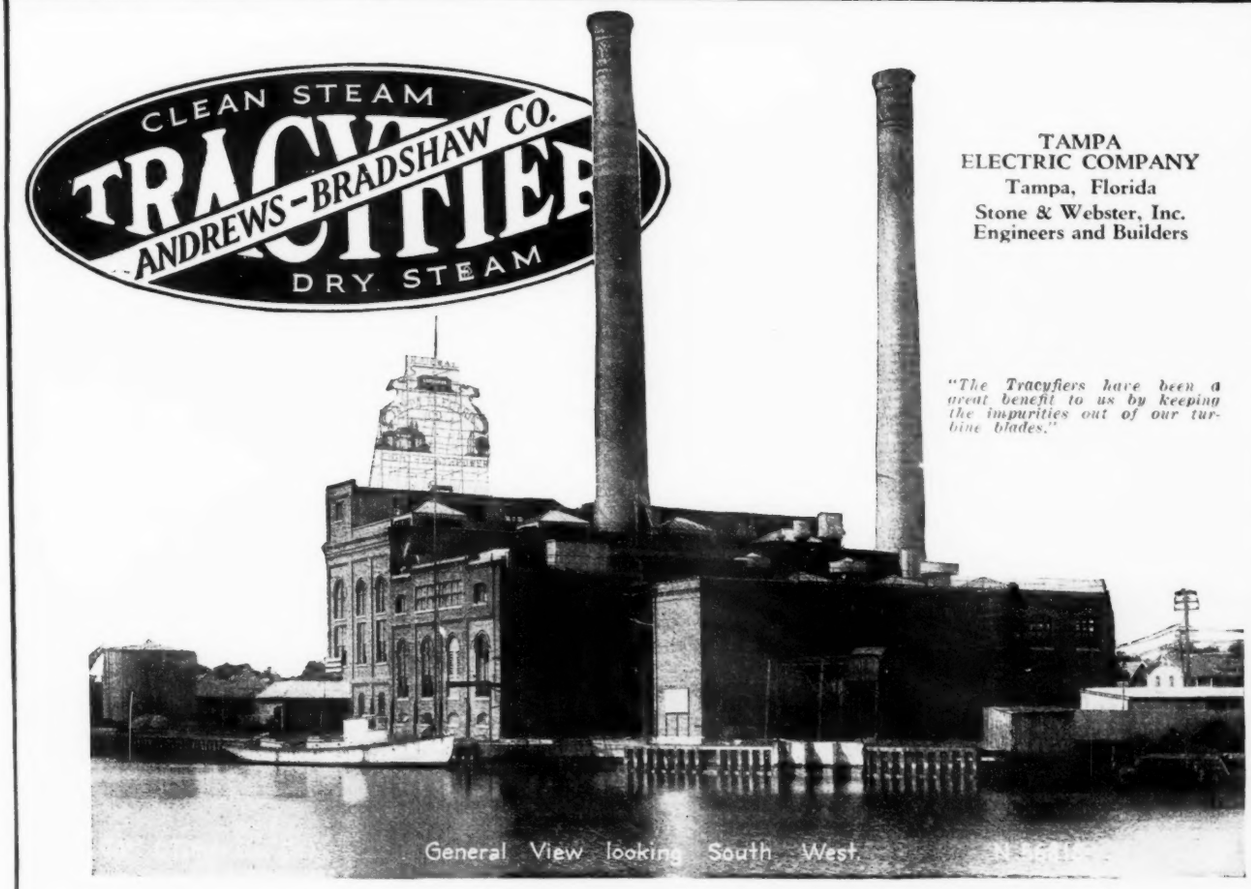

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DELIVER
Standard
Specification
Steam

Ask for Bulletin No. 40 Defining Standard Specification Steam.

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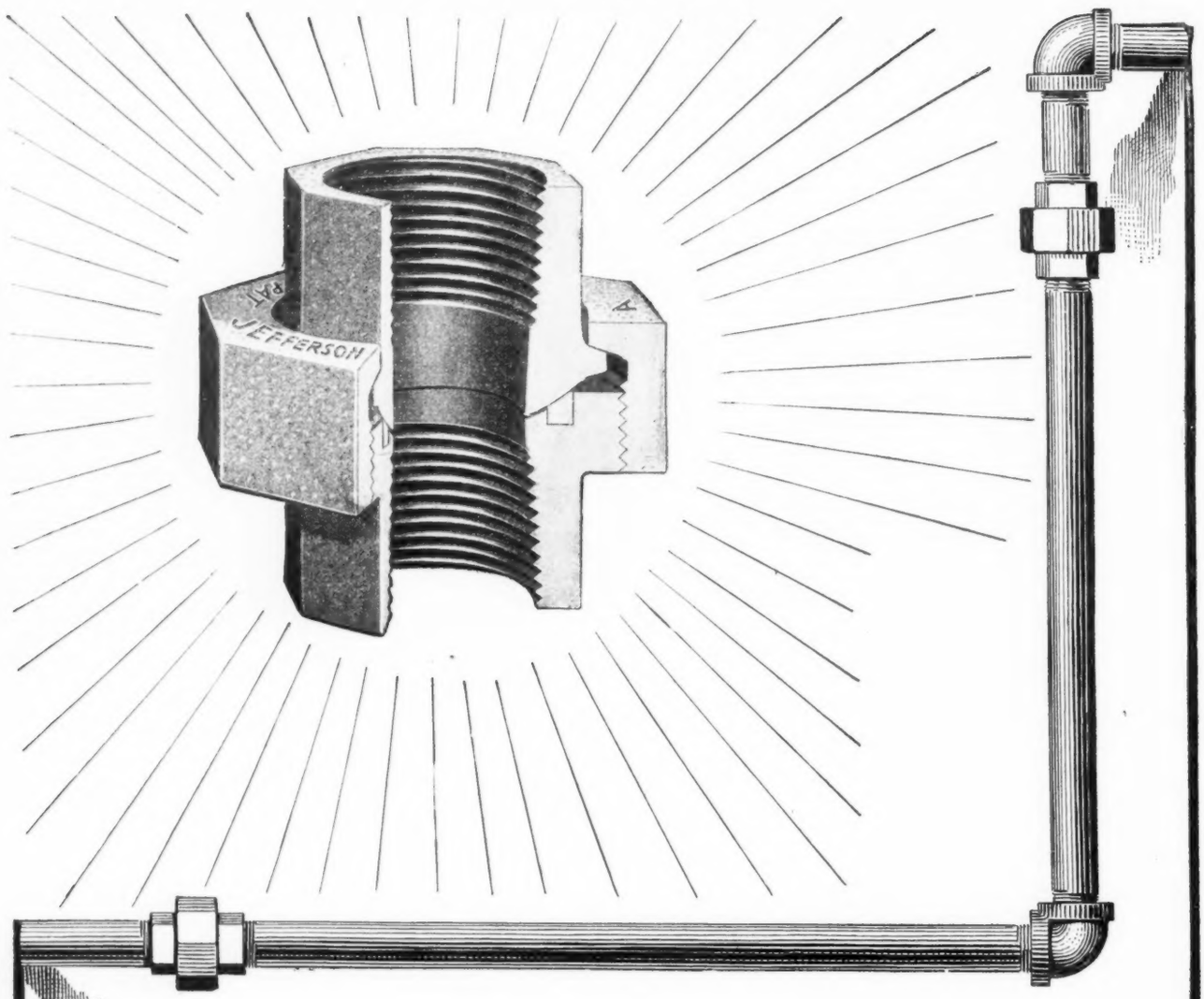
ANDREWS-BRADSHAW CO.

536 Fourth Avenue **Pittsburgh, Pa.**



No. 5 of a series

THE element of chance plays no part in your selection of Jefferson Unions. When you buy these Unions you buy a PROVEN product—proven permanently *leakproof* through long years of service.

You may count on the Unions outlasting the pipe line system itself. You are assured of freedom from leaks and their resultant cost in damage possibly and repairs certainly.

Jefferson Unions are built right. They are made as good as unions can be made—first. Then the price is made as reasonable as possible. In the long run they are the cheapest on the market—they last.

Style D Flange Union

JEFFERSON UNION CO.
LEXINGTON, MASSACHUSETTS

JEFFERSON

for each fuel—

Bituminous

If you are interested in obtaining power efficiently from Bituminous fuel at minimum of expense for up-keep, you will be interested in McClave Bituminous equipment. Each unit is specially designed for the purpose intended under all conditions and ratings.

For instance, the McClave 2-A Grate has long been recognized as standard equipment for burning bituminous and lignite fuels. The same is true of McClave Hand Fired Stokers. With the addition of the McClave Forced Draft and Natural Draft Chain Grate Stokers to this group, the McClave bituminous line of combustion equipment is complete.

McClave can serve you in the use of Bituminous or Lignite fuels. McClave service is unbiased as to fuel or unit for the needed combustion.

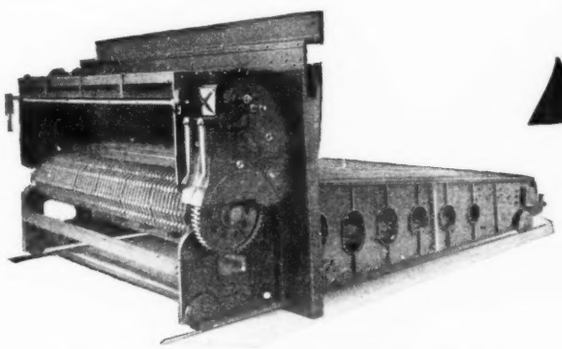
McClave GRATES AND STOKERS

Anthracite

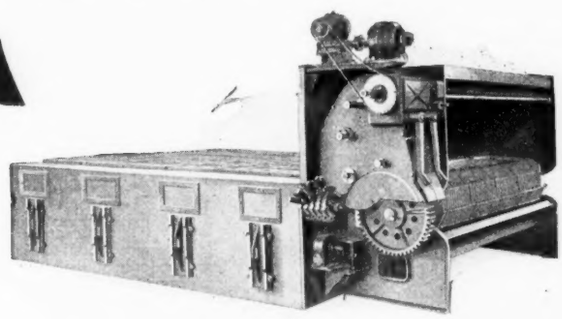
As a user of Anthracite fuel, you desire every ounce of energy obtainable in the production of power. This is possible by using McClave specially designed equipment for burning anthracite. Each McClave Anthracite unit is scientifically designed and built for the purpose of giving highest efficiencies through the control of air and fuel.

The McClave 4-A Grate was the pioneer dumping grate for burning Anthracite and is everywhere accepted as standard equipment in this field. The Type M-A Stoker was also the pioneer in this type of equipment for burning Anthracite. The new Forced Draft Chain Grate Stoker for Anthracite completes the McClave Anthracite line in a way that we believe cannot be matched today by any other manufacturer of combustion equipment.

McClave can serve your Anthracite requirements with unbiased engineering data as to grade of fuel or unit best suited to your requirements.



McClave Chain Grate Bituminous Stoker (Forced Draft or Natural Draft) for all grades of bituminous fuels.



McClave Forced Draft Chain Grate Stoker for all grades of Anthracite, Coke Breeze and Mixtures.

McCLAVE-BROOKS COMPANY

Sole Makers of McClave Grates Since 1883

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ATLANTA, 1328 Candler Bldg. — GREENVILLE, S. C., c/o J. W. Littlefield, Route No. 5 — DALLAS, TEXAS, 307 North Market St.

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McClave COMBUSTION SYSTEMS *for greater economy*

McClave GRATES AND STOKERS

THE LEADERS

Some Republic Flow Meter Users

IRON AND STEEL MILLS

American Rolling Mills.....29
American Steel Foundries.....16
American Steel & Wire Co.....165
Bethlehem Steel Co.....91
Carnegie Steel Co.....95
Charcoal Iron Co. of America.....13
Colorado Fuel & Iron Co.....28
Donner Steel Co.....20
Firth Sterling Steel Co.....12
Illinois Steel Co.....72
Inland Steel Co.....22
Jones & Laughlin Steel Co.....45
Laclede Steel Co.....16
Lukens Steel Co.....14
National Tube Co.....50
National Enameling & Stamping Co.....19
Pittsburgh Steel Co.....12
Sloss Sheffield Steel & Iron Co.....20
Tennessee Coal & Iron R. R.....41
Wheeling Steel & Iron Co.....76
Wisconsin Steel Works.....52
Standard Steel Car Co.....31

AUTOMOBILE INDUSTRY

Buick Motor Co.....24
Cadillac Motor Co.....7
Chevrolet Motor Co.....37
Continental Motors Co.....20
Chrysler Corp.....26
Dodge Brothers.....11
Durant Motor Co.....18
Fisher Body Corp.....11
Forged Steel Wheel Co.....39
General Motors Corp.....7
Hudson Motor Car Co.....30
Nash Motors Co.....9
Olds Motor Works.....4
Seaman Body Corp.....5
A. O. Smith Corp.....21
Studebaker Corp.....16
Timken-Detroit Axle Co.....20

FOOD PRODUCTS

American Maize Products Co.....16
American Sugar Refining Co.....15
Armour & Company.....16
Walter Baker Co., Ltd.....13
Corn Products Refining Co.....49
Cudahy Packing Company.....24
Fleischmann Co.....9
Great Western Sugar Co.....18
Hanford Products Co.....10
H. J. Heinz Co.....50
Hershey Chocolate Co.....22
Libby-McNeill-Libby.....7
Morton Salt Co.....51
National Biscuit Co.....14
Quaker Oats Co.....29
Swift & Co.....58
Wilson & Co.....9

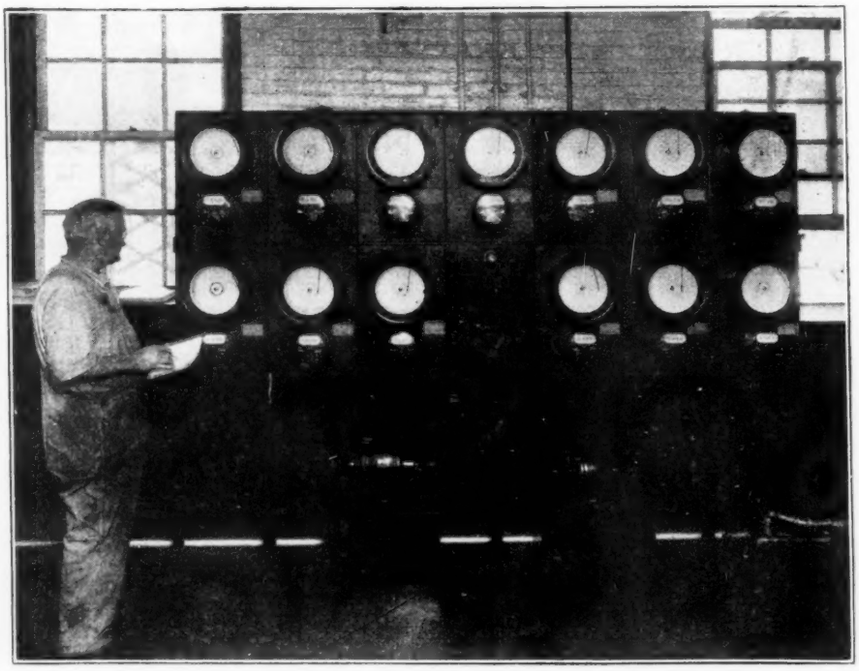
OIL REFINERIES

Cosden Company.....16
Independent Refining Co.....6
National Refining Co.....12
Pierce Petroleum Co.....12
Roxana Petroleum Co.....46
Shell Co. of Calif.....32
Sinclair Refining Co.....10
Solar Refining Co.....9
Standard Oil Co.....228
Sun Oil Company.....14
Texas Co.....20
Vacuum Oil Company.....41

Figures Indicate Number of Meters

At Standard Bleachery Co.

Flow Meters Give



Taking readings from Republics at Standard Bleachery Co., Carlton Hill, N. J.

MR. WM. G. McKINZIE, Treasurer, Standard Bleachery Co., says, "We have a large number of departments using large quantities of steam and our cost records would be worthless if we guessed at the quantity used by each department. Since installing our Republic Flow Meters we have been able to obtain our cost per thousand pounds of steam generated in each boiler house as well as the pounds of steam generated per pound of coal. We are

Bulletin "Steam Economy"
sent on request

ORIGINATORS
of the
ELECTRIC
FLOW METER

The REPUBLIC

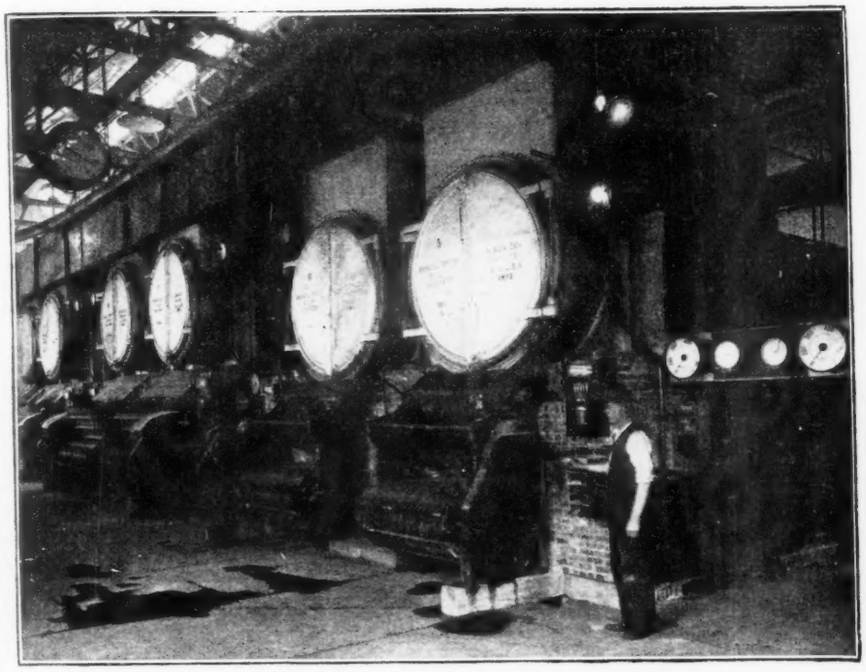
CO₂ Recorders
Boiler Meters

Draft Instruments
Coal Meters

Indicating Pyrometers
Recording Pyrometers

SPECIFY REPUBLIC

Exact Steam Cost



View of boiler room at Standard Bleachery Co., showing Republic instruments mounted on boiler fronts.

also able to determine the value of the steam chargeable to each department.

Even if our Republic Meters didn't save us a cent, we should consider the investment well worth while because of the cost records we can get. These records effect the prosperity of the entire business, and might in these days of keen competition easily mean the difference between success and failure."

REPUBLIC FLOW METERS COMPANY
Executive Offices and Plant, 2222 Diversey Parkway, Chicago, Ill.
Branch Offices in 25 Principal Cities

DOMINION FLOW METERS CO.
Toronto and Montreal, Canada

ELECTROFLO METERS CO.
Park Royal, London, N. W., 10, England

Some Republic Flow Meter Users

PAPER MILLS

Bogalusa Paper Co.	23
Bryant Paper Co.	48
Canadian International Paper Co.	42
Crown Willamette Paper Co.	23
DeGrasse Paper Co.	13
Flambeau Paper Co.	22
International Paper Co.	16
Kimberly-Clark Co.	18
Manistique Pulp & Paper Co.	10
Marathon Paper Co.	37
Minnesota & Ontario Paper Co.	47
National Paper Products Co.	30
Northern Paper Mills	30
Newfoundland Power & Paper Co.	13
Northwest Paper Co.	30
Pacific Mills, Ltd.	14
St. Lawrence Paper Mills	36
Washington Pulp & Paper Co.	19
West Virginia Pulp & Paper Co.	133
Wayagamack Pulp & Paper Co.	18
Yellow Pine Paper Co.	12

BUILDINGS—HOSPITALS—HOTELS

Battle Creek Sanitarium	5
Bellevue & Allied Hospitals	10
Bellevue-Stratford Hotel	4
City Hall, Chicago	3
Edgewater Beach Hotel	5
Federal Reserve Bank	4
General Hospital, Minneapolis	9
Hotel Morrison	11
New Trier High School	7
Palmer House	9
Rookery Bldg.	7
Roosevelt Hotel	3
Hotel Sherman	7
Stevens Hotel	8
Tribune Tower Bldg.	1

CHEMICAL PLANTS

Aetna Explosives Co.	5
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Carter White Lead Co.	6
Dow Chemical Co.	6
E. I. DuPont De Nemours & Co.	136
Grasselli Chemical Co.	54
Hercules Powder Co.	27
Maywood Chemical Co.	10
Merrimac Chemical Co.	14
Rednanol Chemical Co.	6
Sherwin Williams Co.	16
Trojan Powder Co.	6
Textile Dyeing Co.	6
United Piece Dye Wks.	20

TEXTILE MILLS

American Woolen Co.	28
Bellman Brook Co.	11
Bigelow-Hartford Carpet Co.	24
Mt. Hope Finishing Co.	33
Sanford Mills	26
Standard Bleachery Co.	16
Utica Willowvale Bleachery	10
Wyandotte Worsted Co.	14

RAILROADS

A. T. & S. F. R. R.	16
C. B. & Q. R. R.	10
C. & N. W. R. R.	2
Illinois Central R. R.	3
Norfolk & Western R. R.	3
Pullman Car Co.	4
Reading Lines	35

Figures Indicate Number of Meters

FLOW METERS

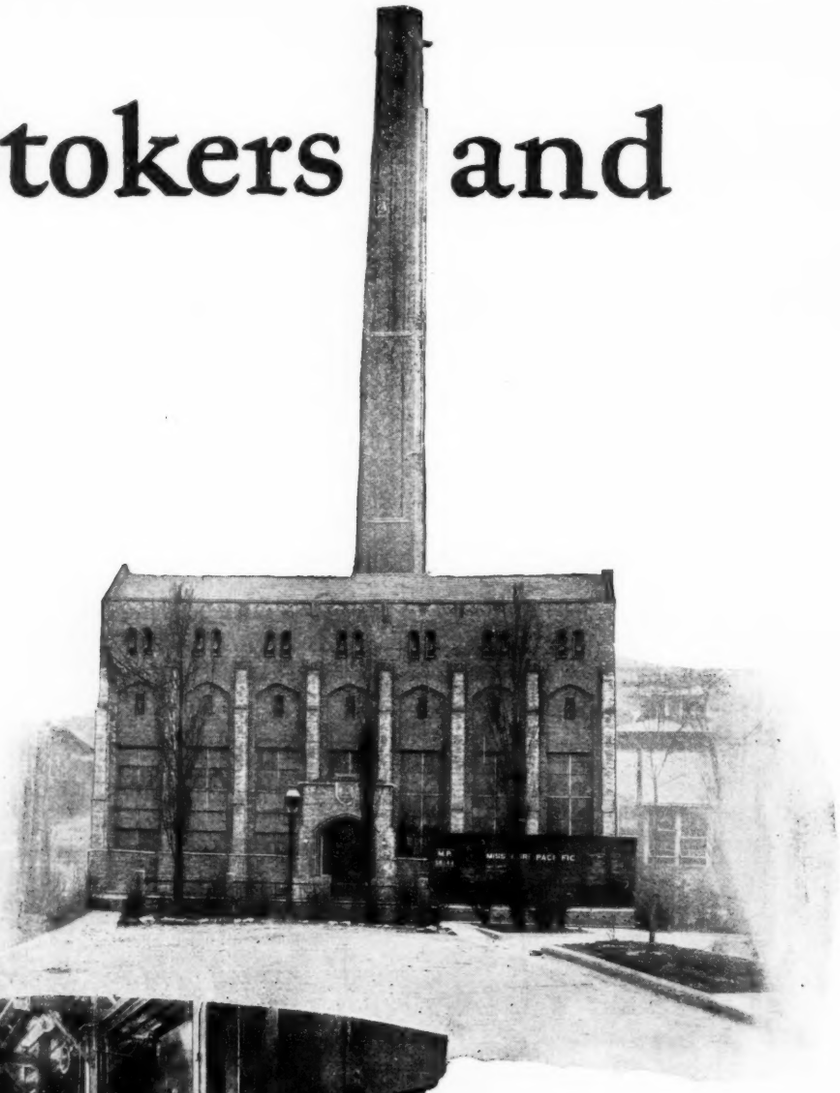
Republic Meters

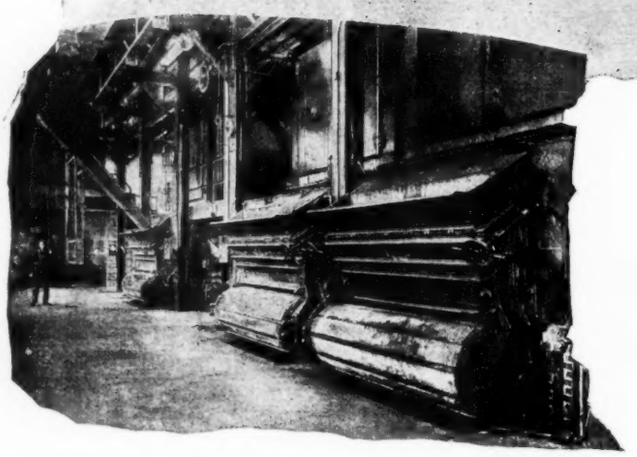
Liquid Level Indicators
Liquid Level Recorders

Gas Meters
Air Meters

Water Meters
Steam Meters

Coxe Stokers and





INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

Fuel Burning and Steam Generating Equipment
Lopulco Storage System (Pulverized Fuel)
Lopulco Unit System (Pulverized Fuel)
Raymond Pulverizing Mill
C-E Fin Furnace
C-E Air Preheater
Frederick Multiple Retort Stoker
Type E Stoker
Type K Stoker
Type H Stoker
Coxe Stoker
Green Natural Draft Stoker
Green Forced Draft Stoker
C-E Ash Conveyor
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Combustion

International Combustion Building Corpor

A SUBSIDIARY OF INTERNATIONAL

Heine Boilers at Washington University

THE power plant at Washington University, St. Louis, is a splendid example of a modern steam generating station of medium size.

Architecturally, it was designed to add beauty and dignity to the University grounds. Mechanically, nothing has been spared to make its operation as efficient and clean as possible.

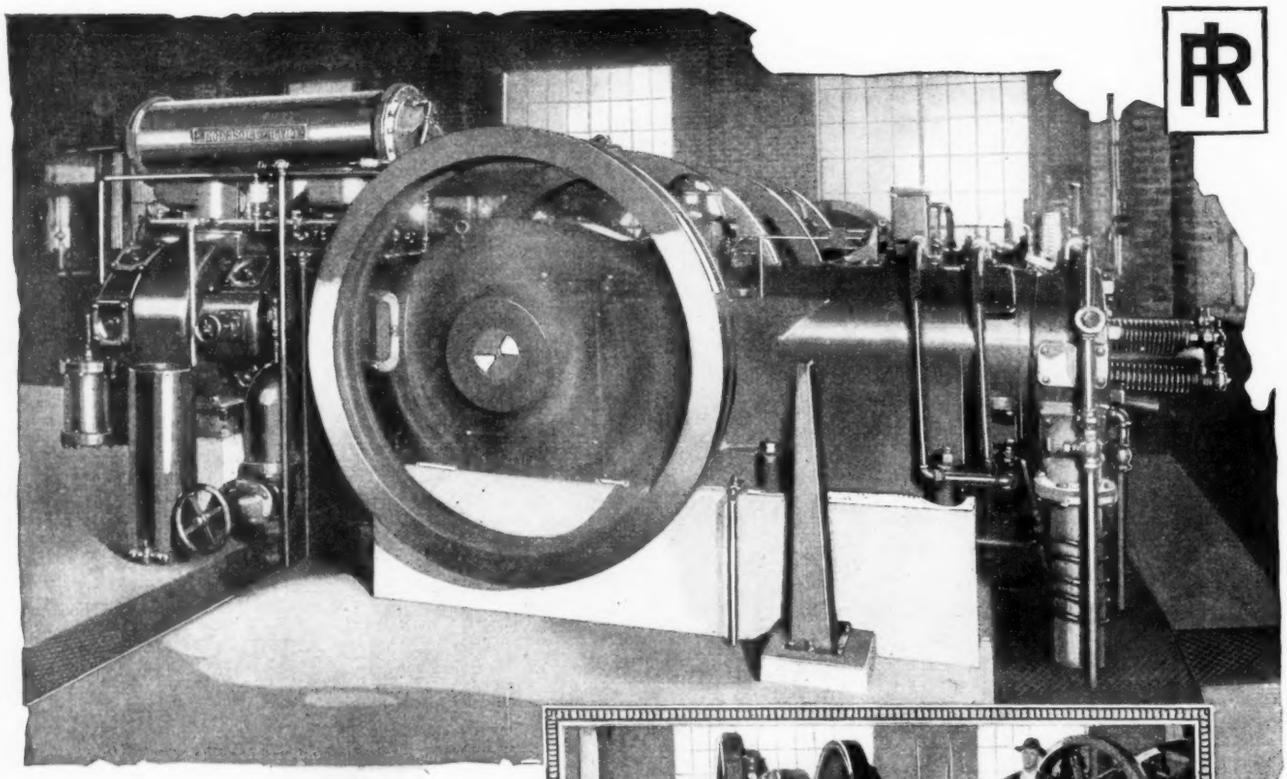
Coxe stokers, burning low grade Illinois coal assure low fuel costs.

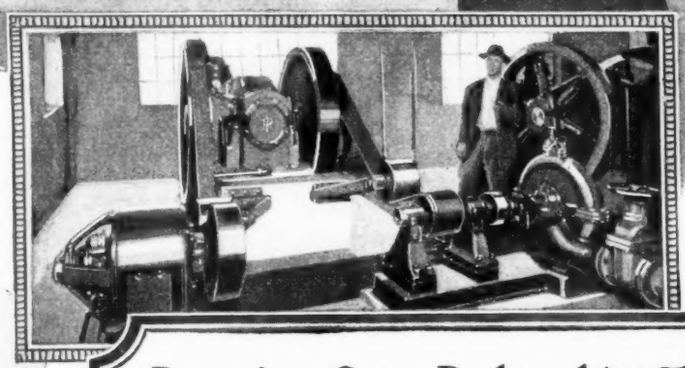
Heine cross drum boilers assure dependable and efficient production of steam.

This plant is typical of scores of modern, well designed and well operated power plants where Combustion Engineering products have been selected after careful comparison of operating costs.

Engineering
ation 200 Madison Ave (35th to 36th St.) New York

COMBUSTION ENGINEERING CORPORATION





Pumping Costs Reduced 70%

The City of Norman, Oklahoma, has reduced its water pumping costs more than 70 per cent by using oil engine air compressors in place of the steam plant that was formerly employed for that purpose.

By means of air lifts, the water is brought to the surface from a number of Artesian wells. The air lifts are operated by two 600-cubic-foot Ingersoll-Rand POC-2 Oil Engine Air Compressors. A 55-hp. PO Oil Engine belt-drives a centrifugal pump.

Ingersoll-Rand Engineers will gladly explain the many ways of reducing costs with oil engine compressors. Write for Bulletin No. 10204.

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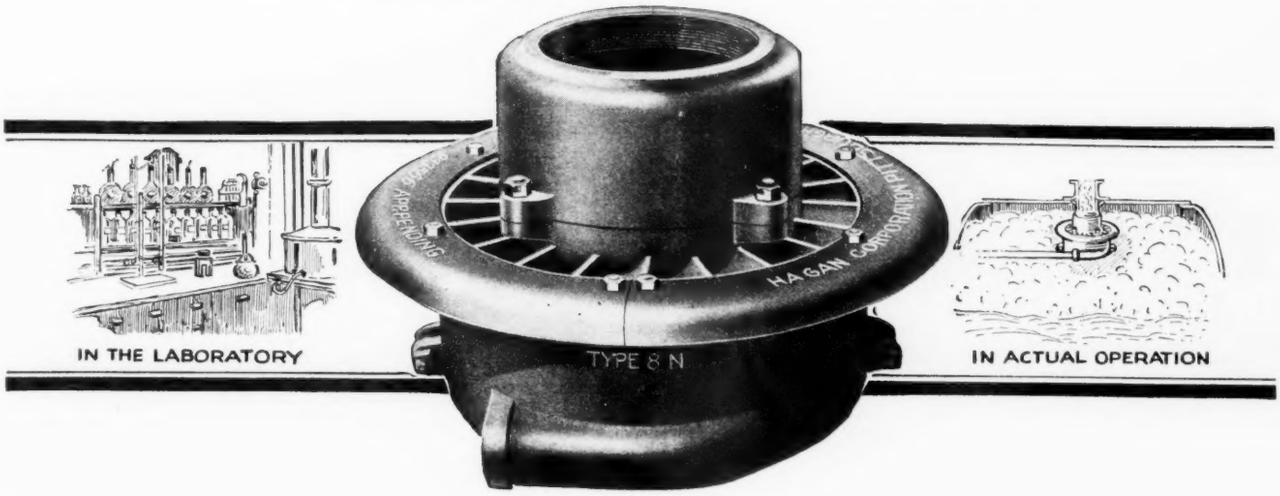
Proved in the laboratory in actual operation



HAGAN Steam Purifier

The
HAGAN
Organization

consists of a group of chemical and combustion engineers who are thoroughly versed in the subjects of combustion and boiler operation. Men who can answer questions on the spot and capable of talking over your troubles with a view to correcting them.

Laboratory tests are essential to any product but the real test is in everyday use under actual operating conditions.

More than 700 Hagan Steam Purifiers were in service before they were put on the market. There's no guesswork about their ability to deliver clean, dry steam. They have proved themselves both in the laboratory and in the plant.

Our booklet "The Wet Steam Problem" contains many interesting facts about this compact, sturdy apparatus. Write for a copy today.

HAGAN CORPORATION

Combustion and Chemical Engineers

502 BOWMAN BUILDING **PITTSBURGH, PENNA.**

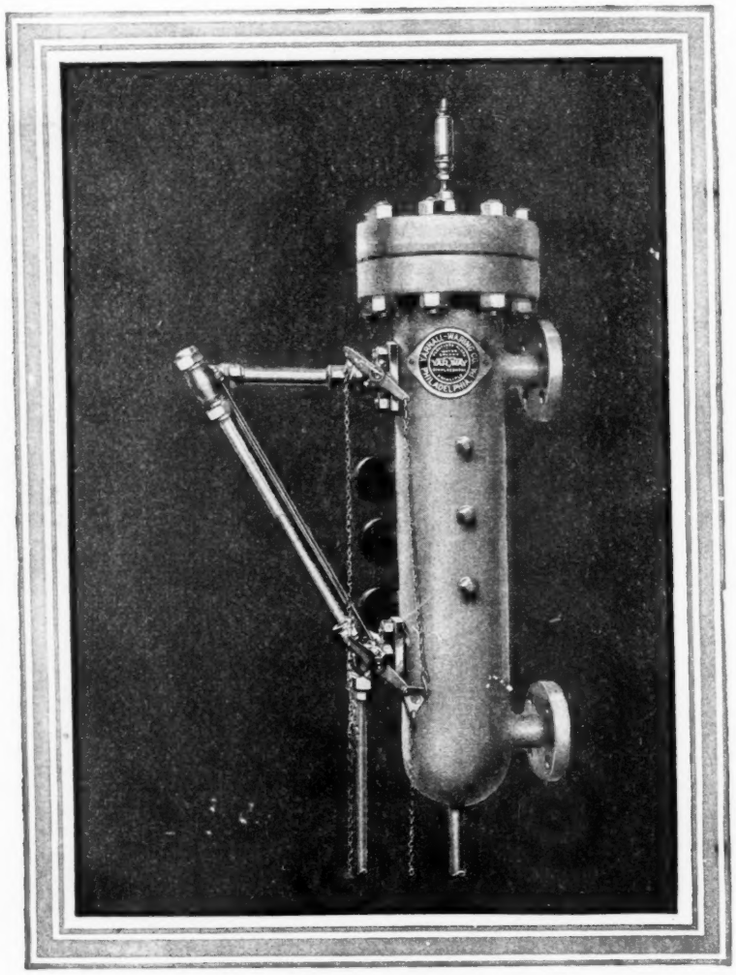
Sales and Service Offices in all principal cities of U. S. A. and foreign countries

The Yarway Floatless Hi-Lo Alarm Water Column

Displacement Principal—No Floats

★ ★ ★

Fig. 4110-52. Forged steel flanges and shell. Flanged boiler and gage connections. Fitted with TYPE E YARWAY-SESURE INCLINED WATER GAGE. For 400 lbs. working pressure.



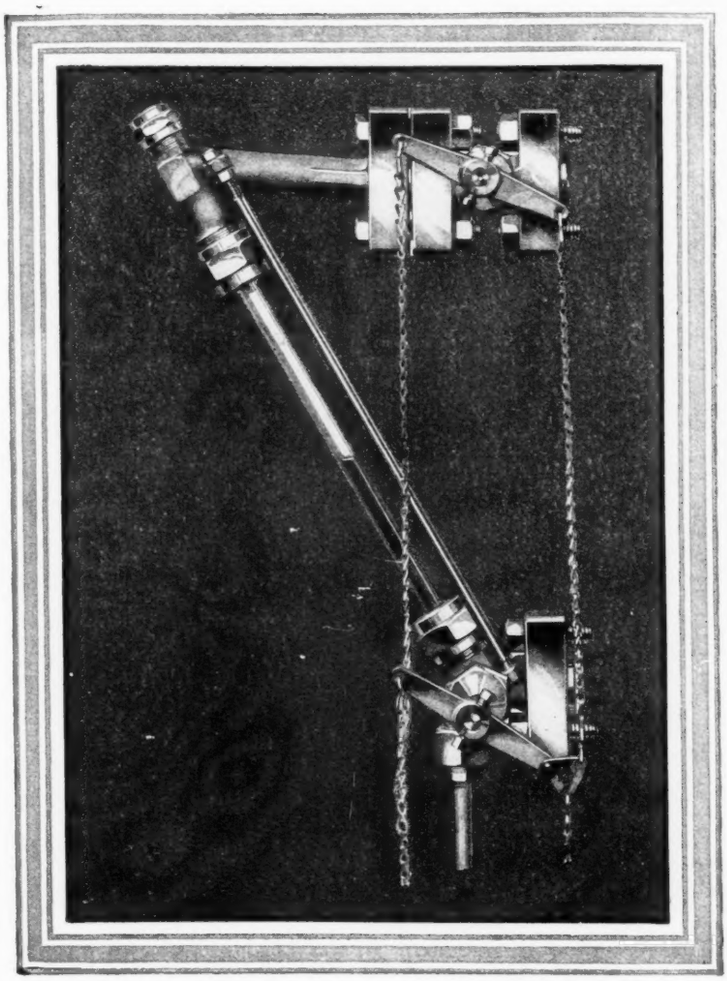
Two *More Yarway*

In the Yarway Floatless Hi-Lo Alarm Water Column, solid weights, rather than hollow floats, operate an alarm signal (whistle or light or both) at high and low water levels. The column body is forged from a steel billet; the flanges are forged. It is furnished in four types for all operating pressures up to 600 pounds, and has been successfully employed in many installations.

The Yarway-Sesure Inclined Water Gage is standard equipment on the Water Column; it is also furnished as a separate unit for any water gage service. It provides for instant reading of the water level from any

THE YARWAY TANDEM BLOW-OFF VALVE, NO. 3486-58 for pressures up to 300 pounds. Another member of the Yarway family. Other types are available for all operating pressures up to 1350 pounds. See Bulletin B-410-C.

YARWAY



The Yarway-Sesure Inclined Water Gage

★ ★ ★

Fig. 4154, Type C. Extra heavy flanged connections for working pressures up to 450 lbs.

Devices to Serve You

position, irrespective of its height above the operator. Metal parts are of hydraulic bronze; any type of tubular, prismatic or flat glass will be furnished. The glass and boiler connections lie in one plane and the gage glass valves are placed as close as possible to the boiler connections, two features insuring great rigidity and long life. Made in four standard types for all pressures up to 600 pounds.

Both of these boiler devices are illustrated in their several types and described in Bulletin WC-1801. We will gladly send a copy at your request.

YARNALL-WARING COMPANY

Mermaid Avenue **Philadelphia**

BOILER DEVICES

TO MANUFACTURERS OF QUALITY PRODUCTS

"The Crater" from THE WONDER OF WORK. The Vacuum Oil Company is privileged to reproduce here one of a series of drawings of industrial subjects by the late Joseph Pennell, one of America's great artists. Courtesy of the J. B. Lippincott Co.

TO MANUFACTURERS OF QUALITY PRODUCTS

Your Hidden Values

The fine products you make are more than they appear. All that has gone into their making cannot be visible on the surface. One must know them to know their character.

Here is a factor in your business and in ours.

With infinite care we make important products which stand in the market alongside goods that resemble them in some unimportant points.

The unimportant resemblance brings other products some acceptance. But it is only real quality that brings the recognition which our products in service have gained—which has earned for us world leadership in the field of lubrication.

Infinite care — An example

The Vacuum Oil Company's Engineers recently were brought together for an International Conference. Men from every important engine-building country met daily for six weeks for this single purpose:

To study the specific lubrication problems presented by one rapidly developing group of engines—and to standardize recommendations for their correct lubrication throughout the world.

We find that continual research is essential to effective plant lubrication. Our scientifically selected oils offer the following advantages:

Uninterrupted service—because of fewer machine breakdowns.
Greater mechanical efficiency—because of minimum friction.
Economy in lubrication—because of less oil required.
Reduced machinery depreciation—because of less wear.

As effective lubrication should be constant, our service is continuous. After we are engaged to supply lubrication we keep in regular touch with the plant personnel and, with their cooperation, maintain desired results.

Our oils and our services, used by quality manufacturers and builders of mechanical equipment throughout the world are at your command.

Vacuum Oil Company

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GARGOYLE

Lubricating Oils
for Plant Lubrication

A 22,000 sq. ft. C. H. Wheeler Surface Condenser in the Binghampton Light, Heat and Power station at Johnson City, N. Y.

Another Specific Installation

This 22,000 square foot Surface Condenser is serving a 25,000 k.w. turbine in the Binghampton Light, Heat and Power station at Johnson City, N. Y. (W. S. Barstow Management Association, Inc., Operating Managers).

C. H. Wheeler Condensers and Auxiliaries are installed only after a careful study has been made of all operating conditions. Over 3500 installations of all sizes have given us a knowledge of the requirements that has earned for us the name—Condenser Specialists.

C. H. Wheeler engineers are prepared to furnish expert information in regard to your specific condenser requirements. Write for full information.

We manufacture:

Surface, Jet and Barometric Condensers; Leach Fracto Control Condensers; Oil Vapor Condensers for High Vacuum Distillation; Heat Exchangers; Sand Separators; Radojet Air Pumps for vacua up to 29.95 inches; Forced and Natural Draft Cooling Towers.

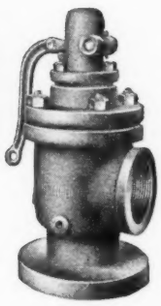
• • •

C. H. WHEELER MFG. COMPANY

19th St., Lehigh & Sedgley Aves. Philadelphia, Pa.

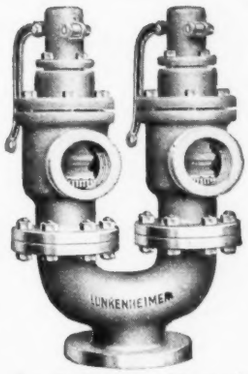
C. H. WHEELER of PHILADELPHIA

FOR SAFETY'S SAKE!



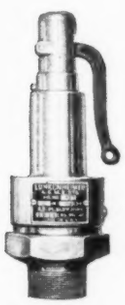
Iron Body
Bronze Mounted
Encased Spring
Pop Safety Valve

Iron Body
Bronze Mounted
Outside Spring
Pop Safety Valve



Iron Body Bronze Mounted
"Twin" Pop Safety
Valve

Bronze
Encased Spring
Angle Outlet
Pop Safety Valve



Bronze
Encased Spring
Top Outlet
Pop Safety Valve

Bronze
Outside Spring
Angle Outlet
Pop Safety Valve

Bronze
Cylinder Relief Valve
Male Inlet
Angle Outlet

Bronze
Cylinder Relief Valve
Male Inlet
Top Outlet

This Coupon will bring the "Guide to Better Service"

LUNKENHEIMER
Pop Safety and Relief Valves

A complete line of a large number of designs, made in various combinations of materials, permitting of a wide choice for any service, pressure or temperature.

Reliable, durable and economical in operation and maintenance.

Lunkenheimer Distributors, located in all industrial centers, carry complete stocks and render prompt service. Call on them for Valves and Engineering Appliances.

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Send me, without obligation, the "Guide to Better Service"

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Firm.....

Position.....

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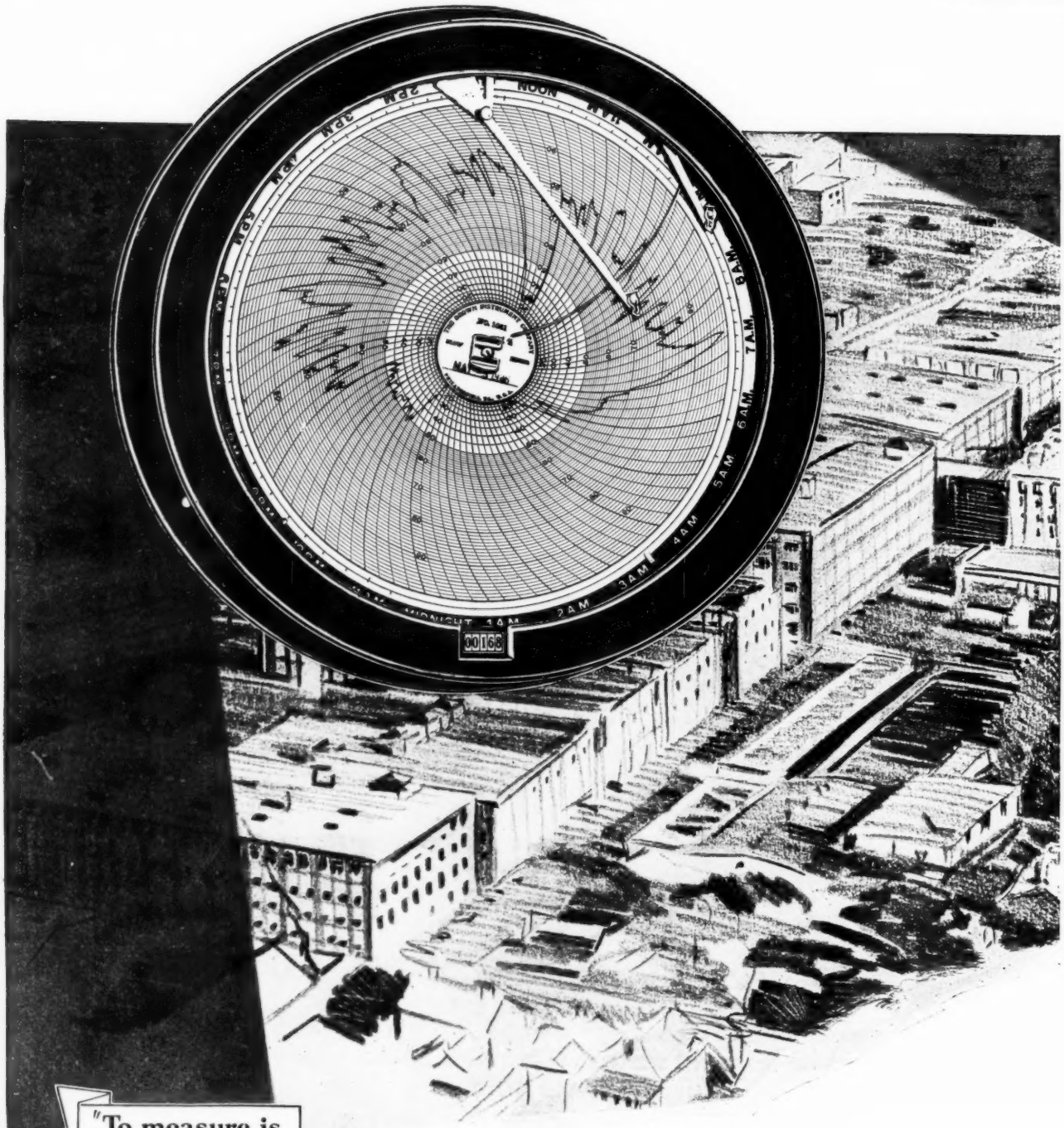
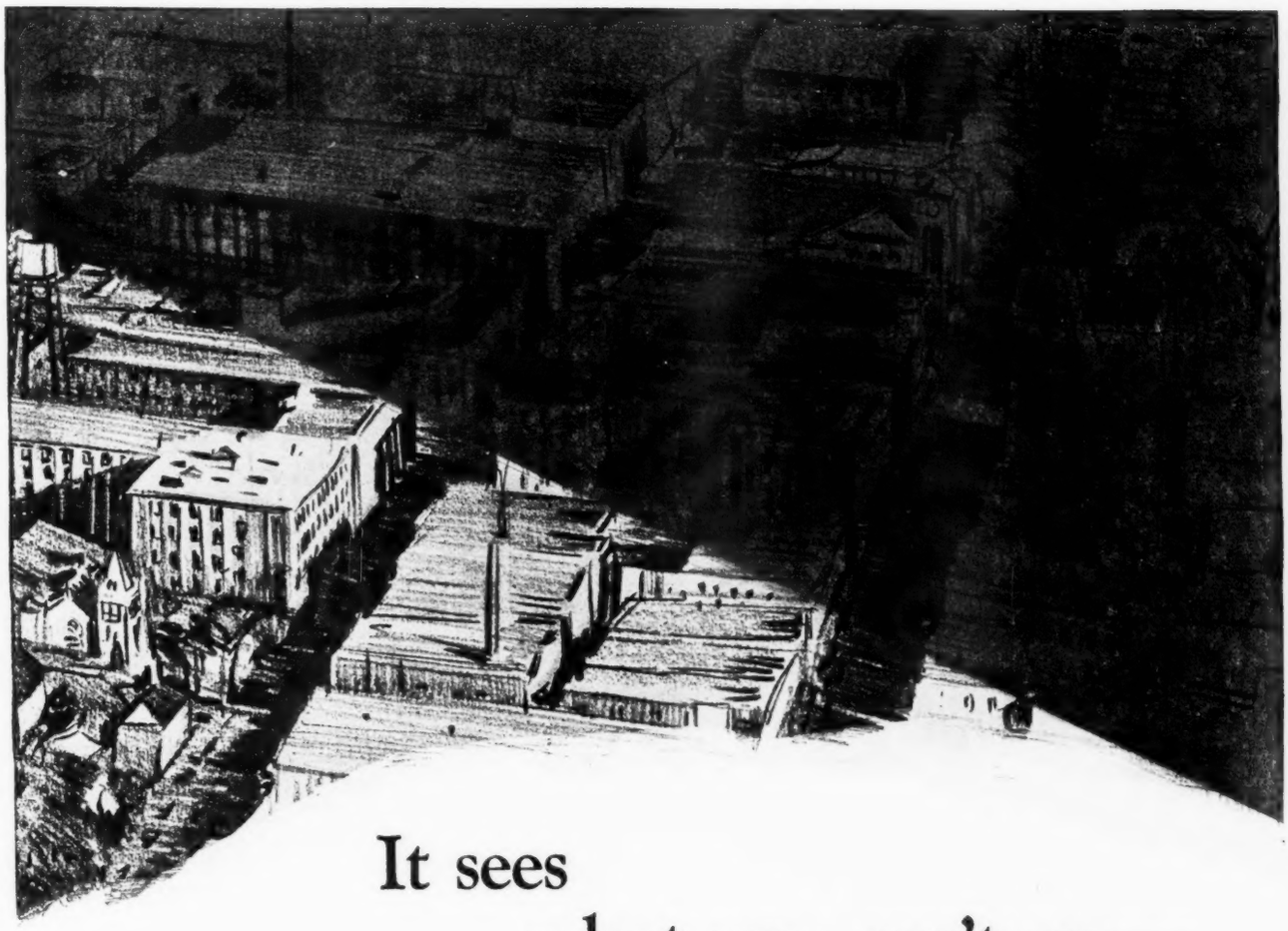


"To measure is to economize"
—PASCAL

The Brown



It sees what you can't see—

Unfortunately you cannot see steam flowing from your boiler room on through your plant from one department to another.

If you could, many ways of saving money and of cutting cost would fairly spring out of you.

The Brown Electric Flow Meter can see for you and warn of losses, the symptons of which even the trained eye of an experienced operating engineer would miss.

The proved-in-service principle of Brown Electric Flow Meters are worth finding out from Catalog 20. Write for your copy.

THE BROWN INSTRUMENT COMPANY
4401 Wayne Ave., PHILADELPHIA, PA.
Offices in Principal Cities

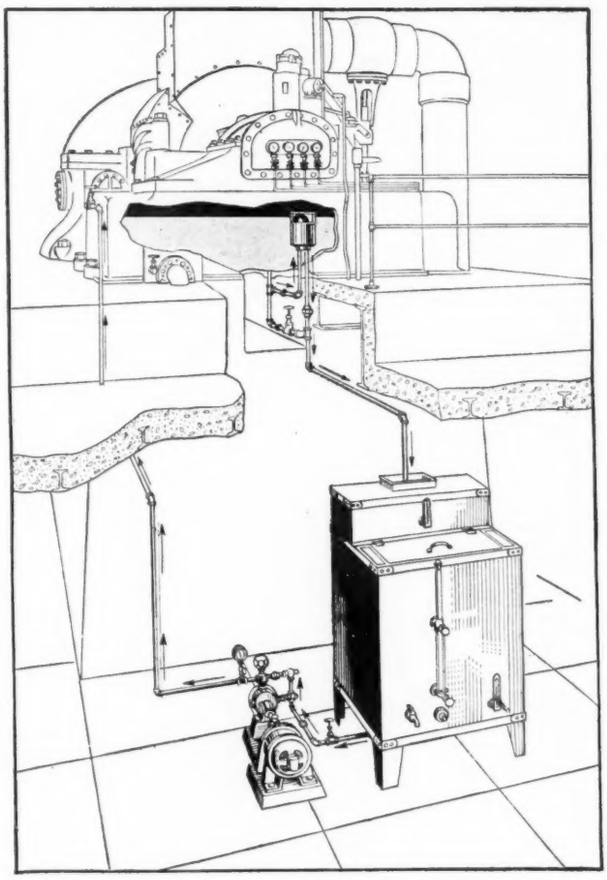
Electric Flow Meter

on the Inductance Bridge Principle

Protective Insurance for Turbine Units

—*But No Annual Premiums!*

Turbines can now be *permanently* insured against shutdowns due to defective lubrication. And Bowser filtration systems do just that—yet the first cost of this insurance is the only cost. There are no annual premiums to pay!



Bowser steam turbine oil filtration systems keep oil clean, cool, and fully efficient. Hundreds of plants have found Bowser units dependable and satisfactory.

If you are concerned with consistent production, you will be interested in the Bowser filtration literature. In asking for it, please address Dept. 6.

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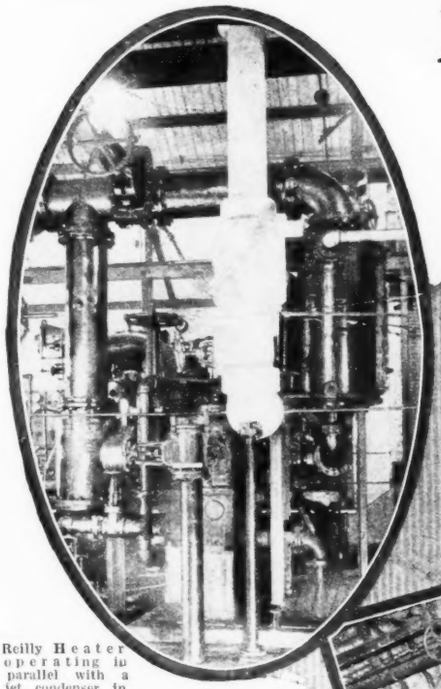
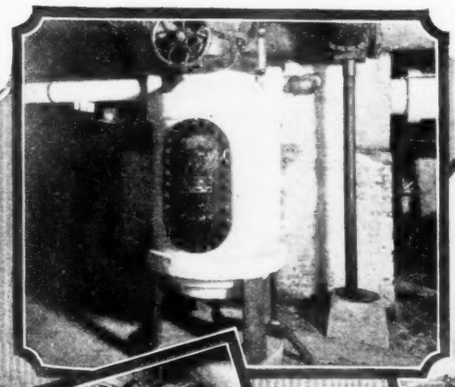
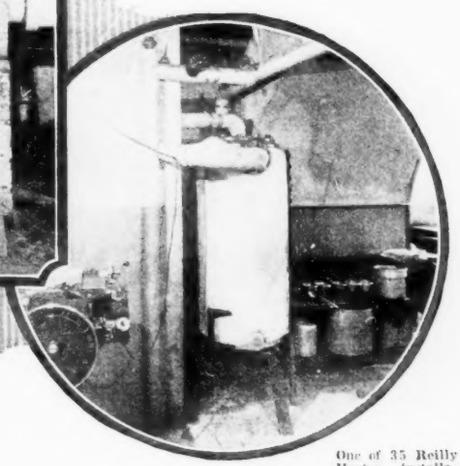


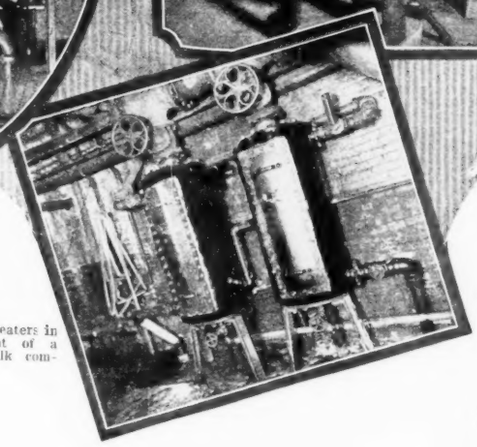
Reilly Heater operating in parallel with a jet condenser in a chemical plant.



Reilly Heater installation in textile plant.

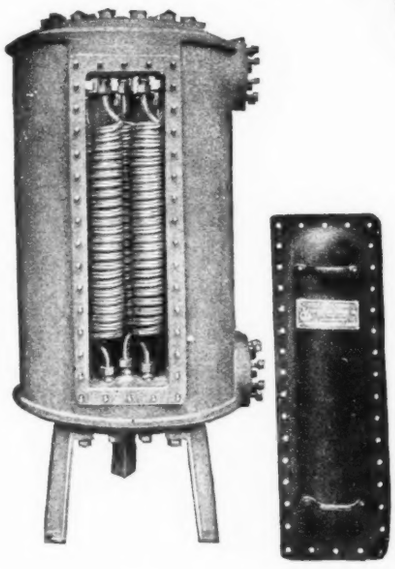


One of 35 Reilly Heater installations in a large chain of restaurants.



Reilly Heaters in the plant of a large milk company.

Reilly Water Heaters



WHEREVER a supply of exhaust or low pressure steam is available, the Reilly Heater is an ideal source of hot water.

It heats the water instantaneously, and during periods of exceptional demand is capable of handling a heavy overload at only a slight reduction of temperature. There is nothing to wear or get out of order, and its simple, sturdy construction, which requires negligible attendance and repairs, keeps down operating costs to a minimum. The steam does not come in direct contact with the water to be heated, so that even dirty steam can safely be used without contaminating the water.

For 35 years the special design of the Reilly Heater has been demonstrating its many practical adventages. In boiler feed service alone, Reilly Heaters are being used on many millions of boiler horsepower.

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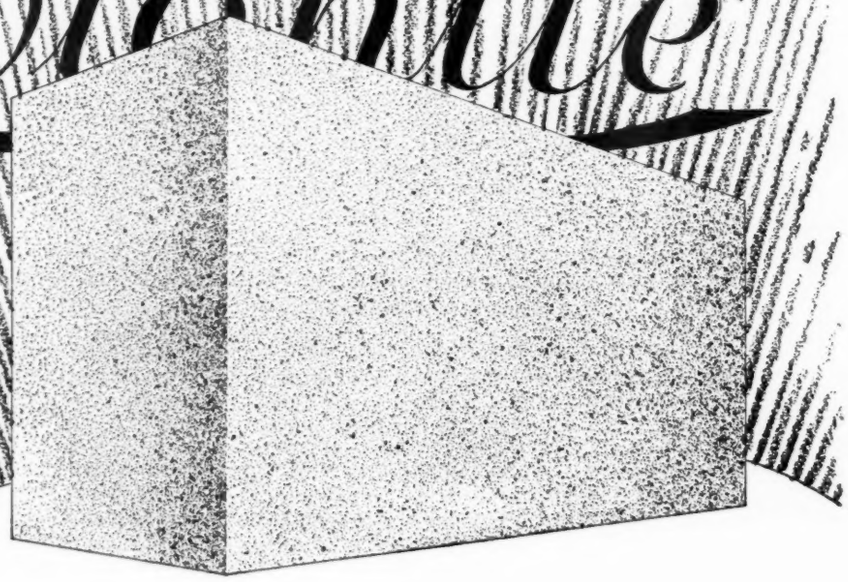

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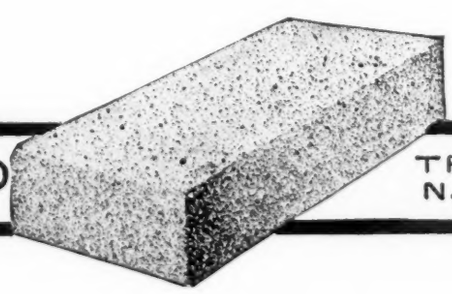

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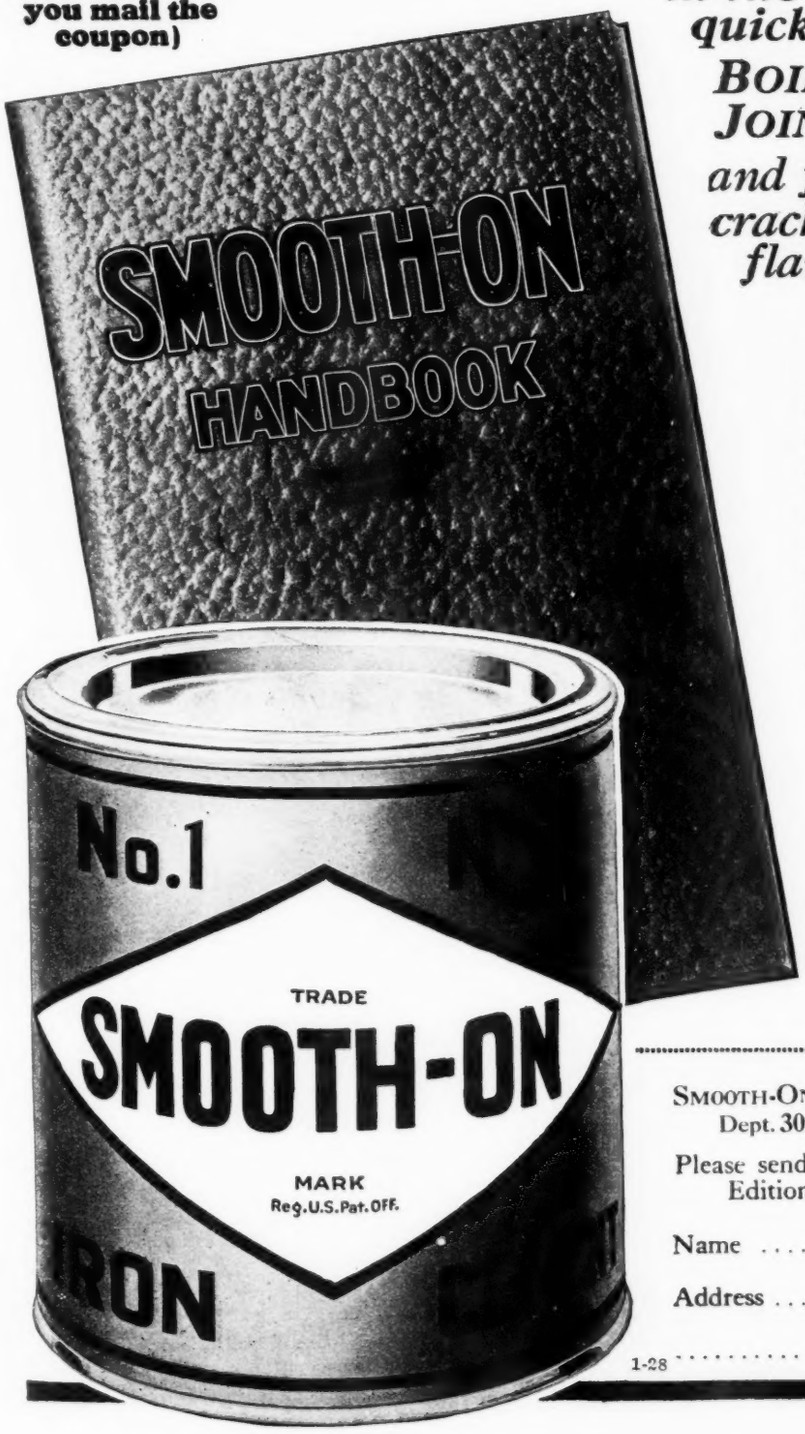

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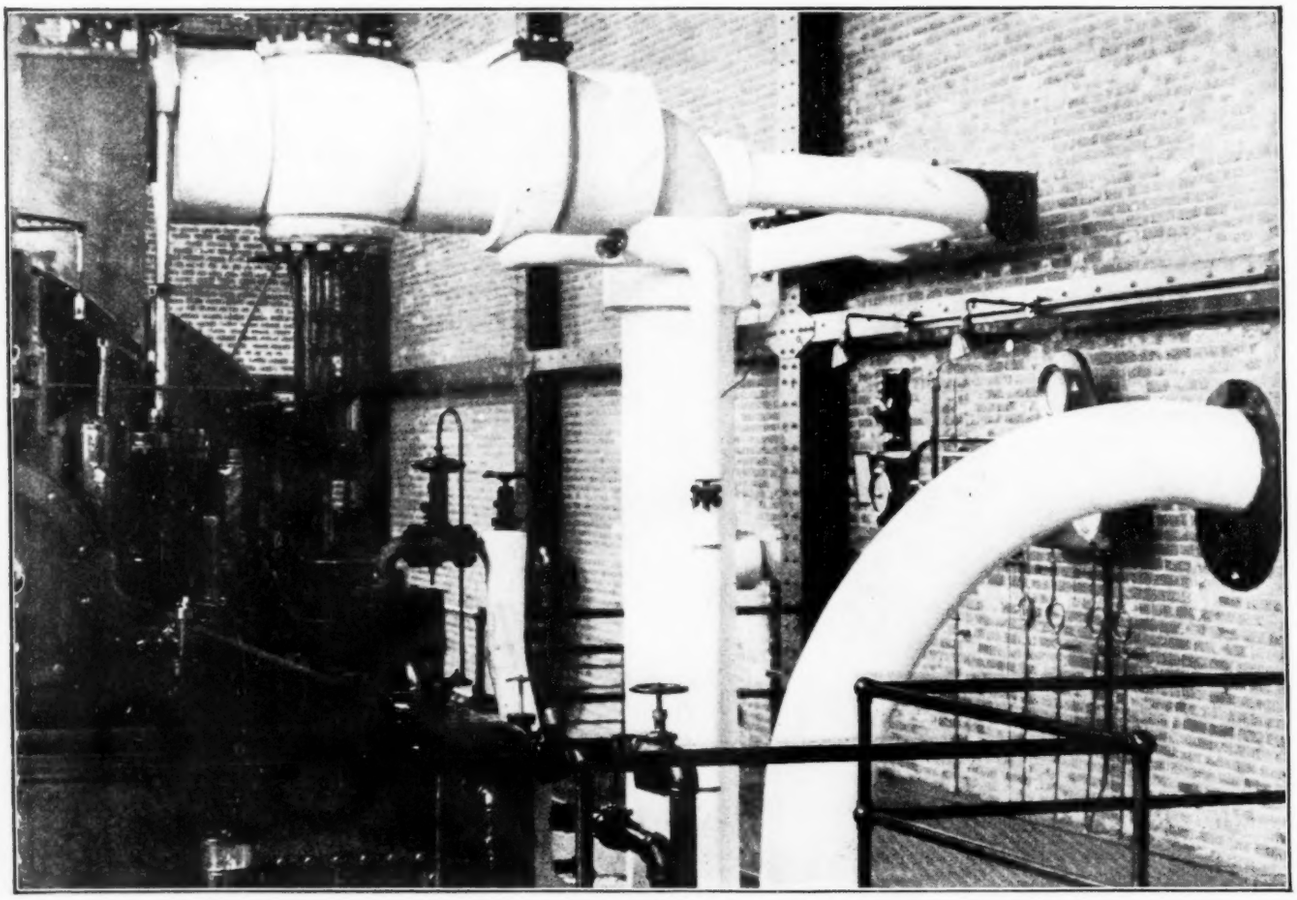

Illustrating Keasbey & Mattison Company's 85% Featherweight Magnesia Pipe Covering on the Cape Steam Station of the Cumberland County Power & Light Company, South Portland, Maine.

The Engineers in charge realizing the importance of efficient pipe and boiler covering, specified Keasbey & Mattison Company's Featherweight 85% Magnesia Pipe Coverings on this very important "Booster" for their Hydro Stations. This plant has modern oil fired boilers equipped with Superheaters of 1950 H.P. Capacity, to drive the 17,500 K.W. General Electric Turbine Units. This splendid insulation is one of the up-to-date features that enables the plant when completely shut down with boilers warm to come on the line and take up the full load in 15 minutes. This duty is required often when the lines are crippled by ice coatings in winter or by lightning storms in summer.

Ask us for other instances and figures showing the real economy of using K & M Featherweight 85% Magnesia Pipe and Boiler Covering. Our Engineering Dept. is at your service.

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WITH modern high rates of driving boilers and the general use of superheaters and turbines, protection against water and scale is something that engineers are looking for in earnest.

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IF YOU ARE BUYING NEW BOILERS you should look into this before the piping which is to connect the boiler drums to the superheater is laid out.

OR, IF YOU ARE HAVING PRIMING TROUBLE WITH AN OLD BOILER INSTALLATION and need help, let our engineers study your conditions, and give you the benefit of their experience. They will be glad to tell you what can be done, and how to do it.

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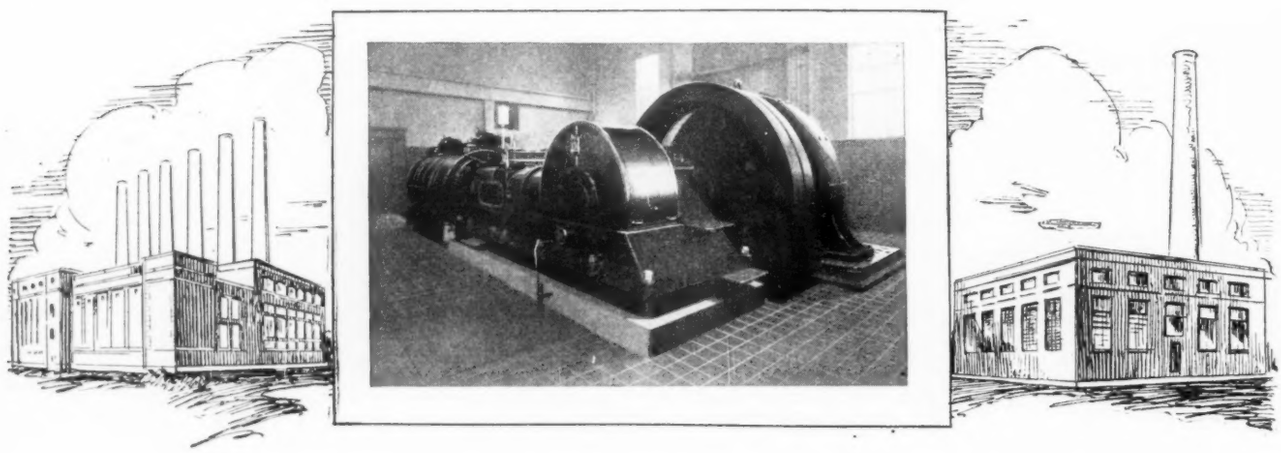

A new manufacturing plant was being erected on property adjacent to a large sub-station of a public utility plant. On the estimated load they could buy current for 1.89 cent a kilowatt-hour.

From our experience gained in installing "Universal Unaflow" engines in hundreds of manufacturing plants, the heating requirements could be closely estimated and, although the central station people insisted that the equipment would lose thousands of dollars a year, we agreed to install an engine with generator under the Skinner Guaranteed Saving Contract, costing $29,761.00, and to take the entire amount in the savings effected.

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This included foundations, switchboard, erection, steam and electrical connections.

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The first few months' operation has convinced the purchasers that the estimated saving of $1300.00 a month is being obtained.

SAVING IN TEN YEARS.....$129,000.00
or more than three times the cost of the plant, plus the plant, on the basis that money saved can earn 6%, and the plant would still be there, good for years of continual service.

If they had purchased central station current, they would have spent this money and all they would have to show for it would be three wires leading into their building and—another bill.

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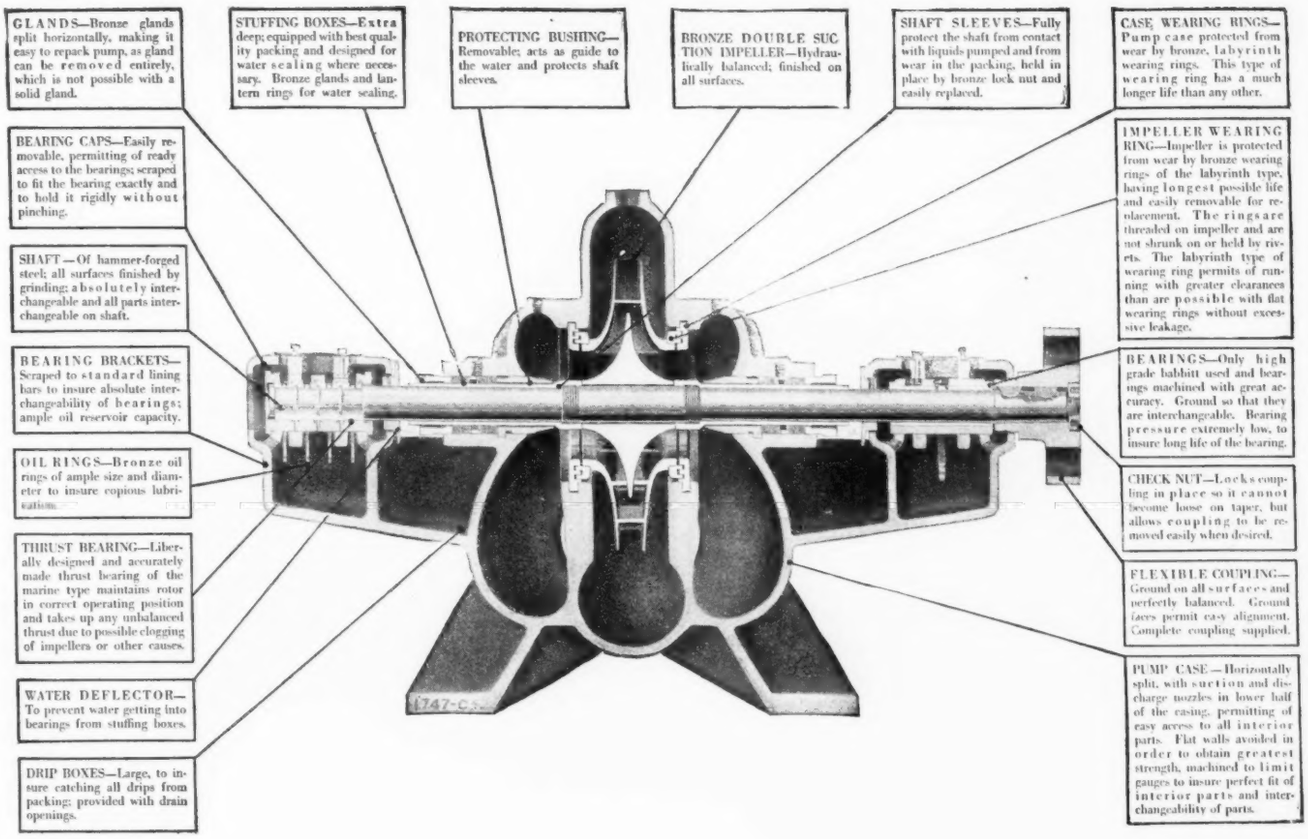
Write for our 32-page illustrated booklet which gives the savings other power users have effected under the Skinner Guaranteed Saving Contract, which provides for our furnishing the equipment with our own money and taking our pay in the savings effected, and then perhaps you will let us survey your power conditions without any expense or obligation on your part.

SKINNER ENGINE COMPANY—Erie, Penna.

Branch Offices in All Principal Cities.


GLANDS—Bronze glands split horizontally, making it easy to repack pump, as gland can be removed entirely, which is not possible with a solid gland.
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BRONZE DOUBLE SUCTION IMPELLER—Hydraulically balanced; finished on all surfaces.
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BEARING CAPS—Easily removable, permitting of ready access to the bearings; scraped to fit the bearing exactly and to hold it rigidly without pinching.
IMPELLER WEARING RING—Impeller is protected from wear by bronze wearing rings of the labyrinth type, having longest possible life and easily removable for replacement. The rings are threaded on impeller and are not shrunk on or held by rivets. The labyrinth type of wearing ring permits of running with greater clearances than are possible with flat wearing rings without excessive leakage.
SHAFT—Of hammer-forged steel; all surfaces finished by grinding; absolutely interchangeable and all parts interchangeable on shaft.
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BEARINGS—Only high grade babbitt used and bearings machined with great accuracy. Ground so that they are interchangeable. Bearing pressure extremely low, to insure long life of the bearing.
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CHECK NUT—Locks coupling in place so it cannot become loose on taper, but allows coupling to be removed easily when desired.
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IT has always been our aim to produce the most sturdy and trouble-proof pump that it is possible to build. De Laval pumps are characterized by liberal design throughout, bearings and oil reservoirs large, bearings of special tin babbitt and amply distant from pump case to prevent overheating when pumping hot liquids, packing glands large and deep, shafts heavy, with perfect balancing of all rotating parts to prevent vibration, wearing rings of double labyrinth type combining wide clearances with efficient performance, freedom from diffusion vanes and similar accessories subject to rapid deterioration, in fact, the best design that long experience can determine.

De Laval pumps are of the volute diffusor type, resulting in high efficiency over a much wider range of capacity and viscosity than is possible with pumps containing diffusion vanes. Every De Laval pump is fully guaranteed as to performance, and a complete test is made before the pump leaves the Works. Due to the comprehensive information which our engineers thus obtain, they are able to supply designs which most successfully meet widely different requirements, and to make reliable guarantees as to efficiency, head and capacity for each individual pump.

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Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery

WHEN POWER FAILS PUMPS STOP

Then what do you do if fire breaks out?

Sterling
High Duty
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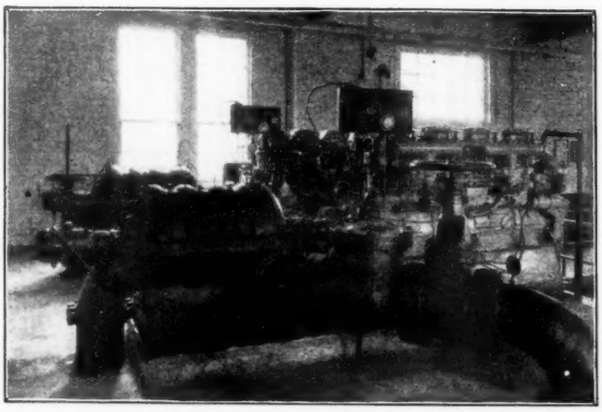

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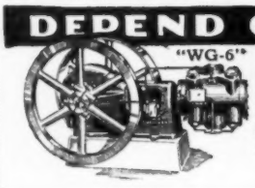

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Diesel Engines
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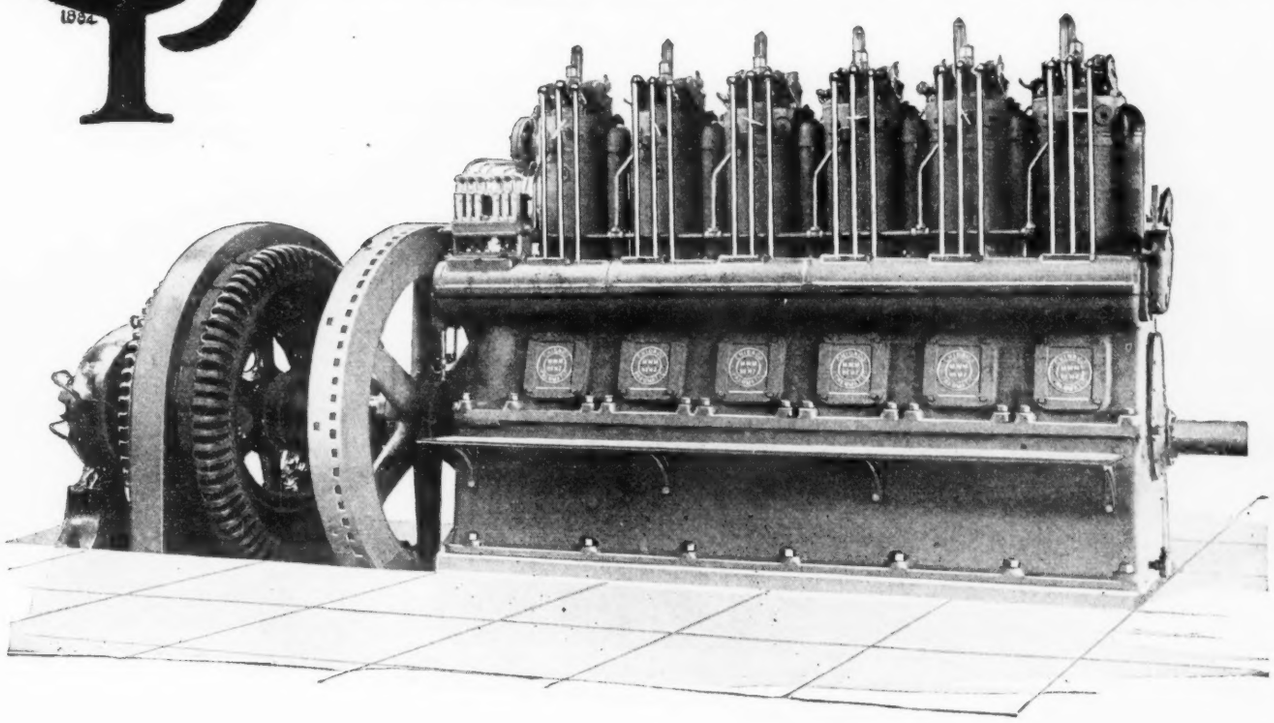

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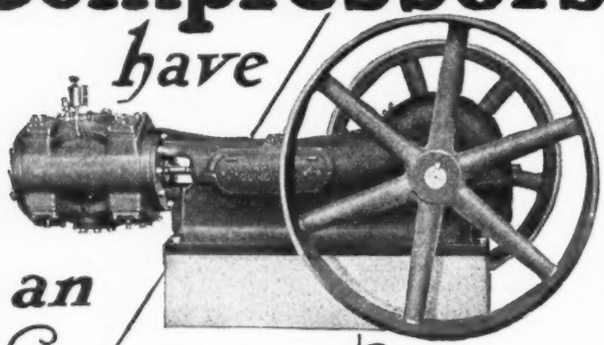

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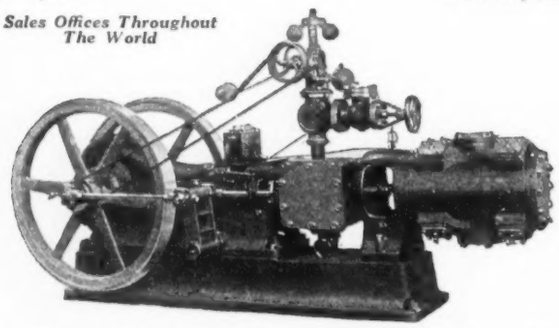

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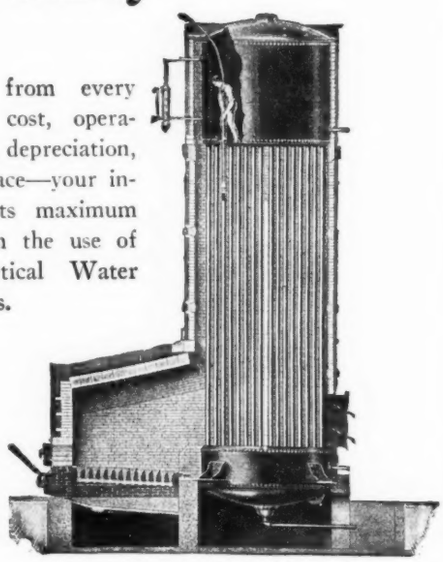
Considered from every angle—first cost, operation, upkeep, depreciation, and floor space—your investment nets maximum returns from the use of Wickes Vertical Water Tube Boilers.



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Have passed the test of time. They are in successful operation in hundreds of prominent manufacturing plants.

The circulation is based on a U-Tube principle, resulting in a positive rapid circulation. Great height between normal water level and steam outlet, together with extra large steam space insures the delivery of commercially dry steam. Conveniently accessible for inspection and cleaning. Steel cased setting—air-tight—adaptable to all methods of firing.

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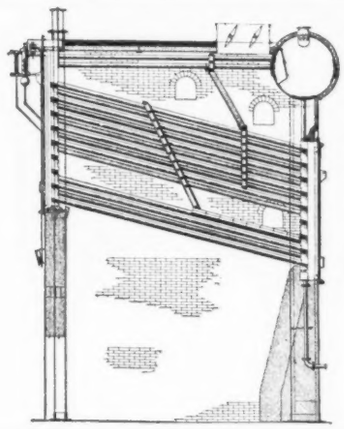

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Pressures up to 650 lbs. Sizes up to 30,000 sq.ft.

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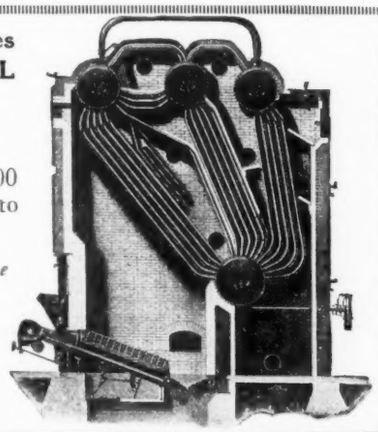
Chattanooga, Tenn.
Representatives in all principal cities



For medium and high pressures

ESPECIALLY suitable for large power plants. Steel construction throughout. Straight tubes. All hand-holes elliptical, their covers internal and removable through their own openings. Unrestricted circulation, permitting forcing of fires with safety and economy.

Send for bulletins on performance

EDGE MOOR IRON COMPANY Edge Moor, Delaware

EDGE MOOR Water Tube BOILERS

FOR INCREASED FUEL ECONOMY

WATER TUBE BOILERS — UNION IRON WORKS ERIE PA. — LONG DRUM CROSS DRUM BENT TUBE

A Subsidiary of **Heine Boiler Company**
INTERNATIONAL COMBUSTION BUILDING
200 MADISON AVENUE
NEW YORK
International Combustion Engineering Corporation

Repairs to Power Plants

Emergency Repairs—Always Ready
Wire us your trouble. Instant Service

H. B. UNDERWOOD CORPORATION
Established 1870 1015-1025 Hamilton St., Phila., Pa.

KINGSFORD

All Steel Sectional Water Tube Boilers

A design and construction that has proved its high efficiency under all steaming conditions. Also builders of horizontal and vertical Unaflow Engines and all types of Centrifugal Pumps. Write for Catalog.

Kingsford Foundry & Machine Works, Oswego, N. Y.

A BIG MARGIN of SAFETY

Enduring transparency with freedom from breakage by cold drafts are vital features upon which the selection of the gage glasses for your boiler water columns should depend.

One hundred and ten years of glass making in America have enabled us to develop LIBBEY HIGH PRESSURE GAGE GLASSES to meet any conceivable operating demand for pressures to 400 lb. No other glass has a greater margin of safety.

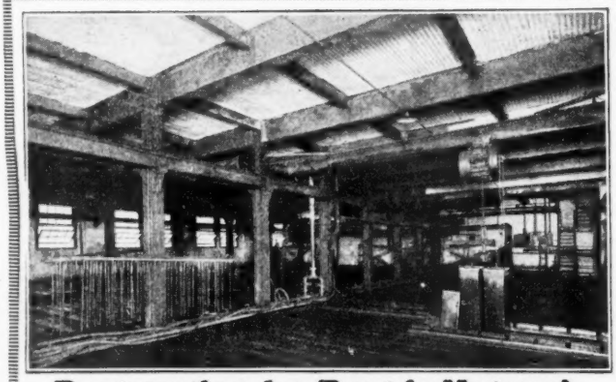
Libbey

High Pressure Gage Glass

Safety and service dominate in every Libbey Gage Glass. No danger of breakage by sudden temperature change. No clouding up—but crystal transparency throughout their long life.

400 lb.

The
Libbey Glass Mfg. Co.
Manufacturers of Railroad and Industrial Glassware
Toledo, Ohio



Destruction by Rust is Nature's Law for Steel

It is one thing to produce a suitable steel and quite another thing to hold it against the continuous effort of nature to reduce it to oxides.

The interior view of a section of a large ice plant here illustrated shows NO-OX-ID in a successful battle against a severe rusting condition. This is one of the hundreds of similar uses in ice plants. At every point where rust is a menace, NO-OX-ID has proven a suitable long-lasting preventive. What is your rust problem?

Correspondence Invited.

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310 S. Michigan Ave., Chicago 299 Broadway, New York
Canadian Offices and Factory: 2454-64 Dundas St., West, Toronto

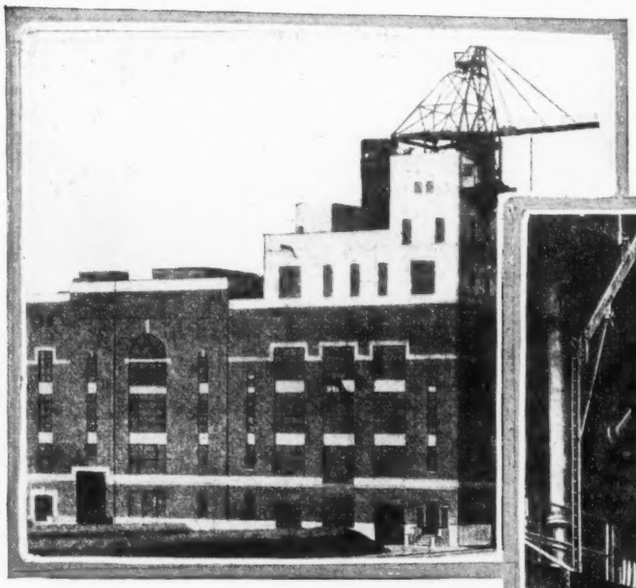
NO-OX-ID
IRON + OX = RUST
TRADE MARK
The Original Rust Preventive

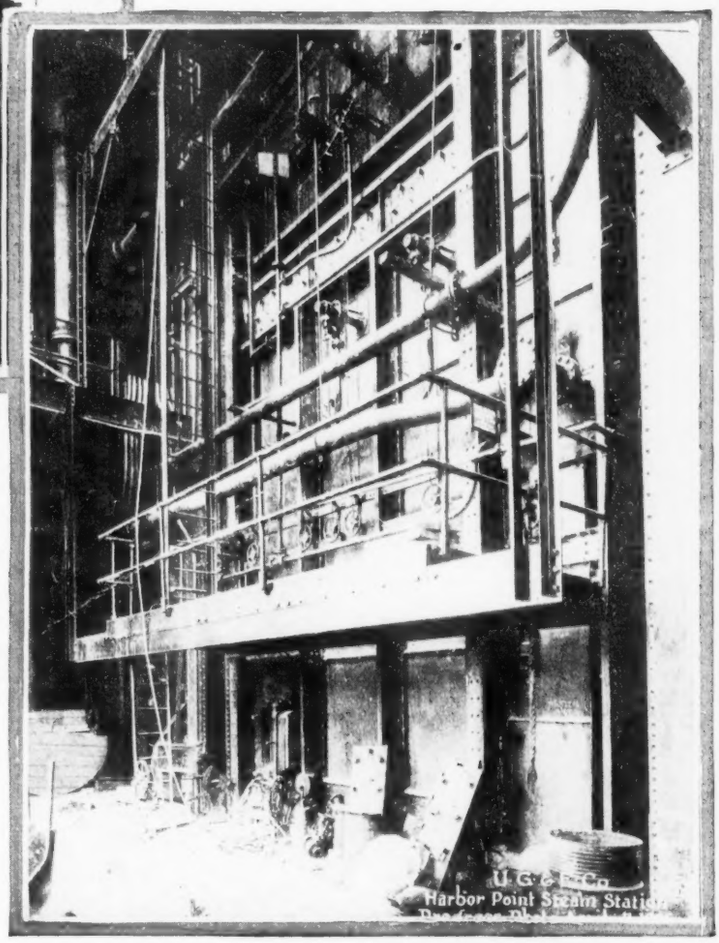
MAGIC BOILER PRESERVATIVE
"The Pioneer Boiler Treatment"
Positively removes and prevents scale, stops leaks, pitting and corrosion
GARRATT-CALLAHAN CO.
San Francisco Chicago New York

APEXIOR REG. U.S. PAT. OFF.
—an accepted protective coating for hot water and steam surfaces of boiler plant equipment.
Write for Bulletin
The DAMPNEY CO. OF AMERICA, Hyde Park, Mass.

LADD BOILERS
INTERNATIONAL COMBUSTION ENGINEERING CORPORATION
Ladd Water Tube Boiler Co
International Combustion Buildin
200 Madison Ave., 35th to 36th St., New York
First National Bank Building, Pittsburgh
A Subsidiary of International Combustion Engineering Corp.

SPRINGFIELD BOILERS
WATER TUBE BOILERS
SECTIONAL
ALL STEEL
Springfield Boiler Co.
Springfield, Ill.





Making sure that the soot is properly blown at Harbor Point

Each of the four stoker fired 16,199 sq.ft. boilers, operating at 290 lb. pressure is equipped with

MARION Soot Blowers

Type "AB"

which were selected by the designers and constructors, Thomas E. Murray, Inc., for the Utica Gas & Electric Co. on a performance and quality basis.

The blowers embody many improvements such as the independently operated Valve-at-Head, Balanced Head that eliminates end thrust, the special alloy internally welded Venturi tube nozzles, and the correct anchorage of the elements to effectively reach every part of the heating surface. The even distribution of dry steam is assured. The elements withstand high temperatures without corrosion. The reduction gear control minimizes the manual effort.

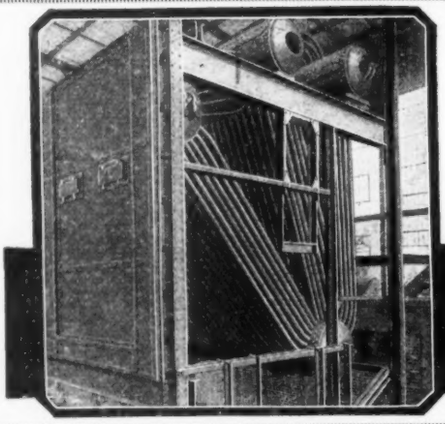
Swivel tube and valve seat are made of monel metal for high duty service.

Let us advise you on the most efficient method of blowing soot from your boilers. Write for Bulletins.

Address Box-A-685

Marion Machine Foundry & Supply Co.

Marion, Indiana



Rapid, Definite, Unrestricted Circulation

ELIMINATES steam pockets which cause the burning out of tubes—prevents unequal expansion. It's one of the many reasons why Connelly Boilers are economical of operation. A fully descriptive catalog will be mailed promptly on request.

Built in units from 200 to 4300 H. P. and for steam pressures up to 450 lbs.

50 Years Knowing how

The CONNELLY BOILER COMPANY Cleveland, Ohio

DURABLA

Trade Mark Reg. U. S. Pat. Office

DURABLA GAUGE GLASS

for

400 Lbs. Steam Pressure

CLEAR "It's Safe LASTING

DURABLA GAUGE GLASS

IS BLOWN FROM THE ORIGINAL DURABLAMASS WHICH HAS NO SUPERIOR.

IT SHOWS THE WATER LINE CLEAR AT ALL TIMES

Durabla Manufacturing Co.

114 Liberty St., New York

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DURABLA

SHEET PACKING—ROD PACKING—PUMP VALVES—VALVE DISCS

Read Water Level from the Firing Aisle

Use the simple, easily attached "P.B.H." Adapter for Water Gauges

Patented Jan. 1927

Especially desirable where gauge glass is located high up on the boiler. Insures easy, accurate reading at a glance.

Built of *EXTRA HEAVY* polished bronze for high pressures.

Easily installed and inexpensive. May be used either right or left hand on any type of water column or direct to boiler or tank.

Send for bulletins on "P.B.H." Boiler Room Specialties.

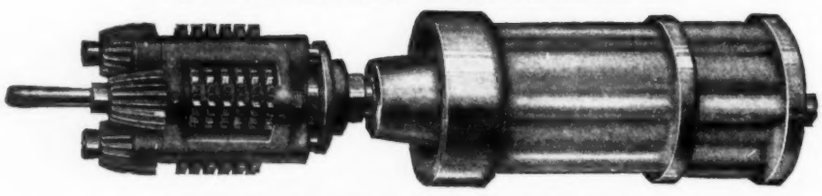
The Paul B. Huyette Co., Inc.

5 South 18th Street, Philadelphia, Pa.

Save Time and Expense in Boiler Cleaning

By cleaning as often as possible—instead of only when you must

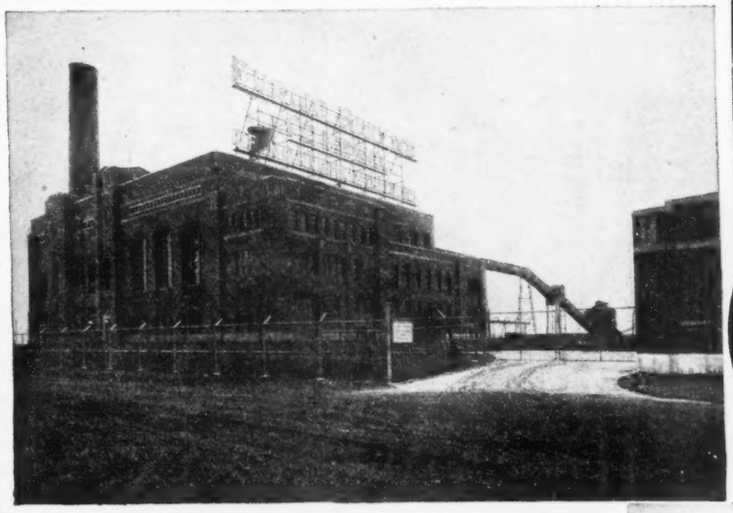
Roto Tube Cleaners

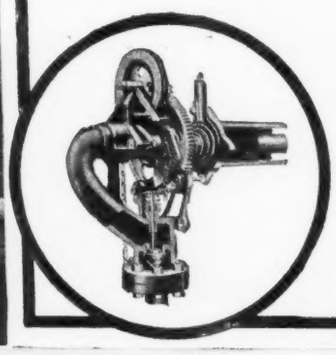


Roto 4 in. Heavy Duty Air-Driven Tube Cleaner

THE ROTO COMPANY, Sussex Ave. and Newark St., NEWARK, N. J.

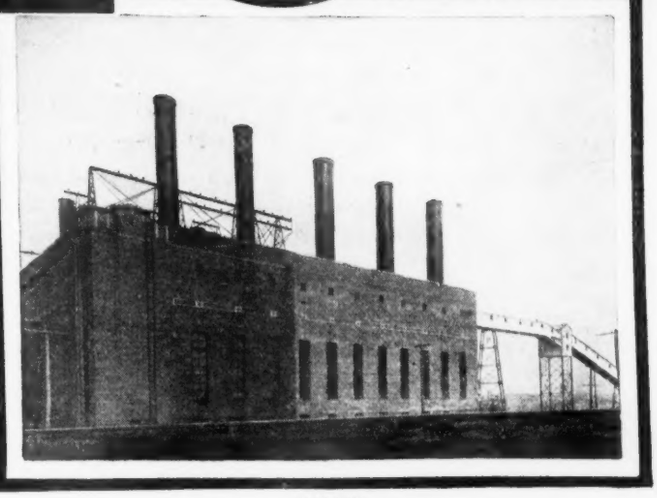
Diamond Equipped





WAUKEGAN

The PUBLIC SERVICE Company of NORTHERN ILLINOIS



JOLIET

THE Public Service Company of Northern Illinois has used Diamond Automatic Valved Soot Blowers in several of its stations for years. They are in a position to know the economic value of mechanical soot blowers—and particularly to know the merits of the Diamond design and construction.

DIAMOND POWER SPECIALTY CORPORATION
DETROIT, MICHIGAN

Diamond AUTOMATIC VALVED SOOT BLOWERS—"VALV-IN-HEAD"

The Babcock & Wilcox Tube Co.

Manufacturers of

SEAMLESS

STEEL TUBES

For Stationary, Locomotive and Marine Boilers

For over twenty years, the Company's mills have been making high grade tubes for Babcock & Wilcox boilers. The same careful selection of raw materials, close supervision of manufacture and rigid final inspection are followed whether the tubes are made for Babcock & Wilcox boilers or for any other purpose.

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Chicago, Marquette Bldg.
Philadelphia, Packard Bldg
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How Are Your Boiler Tubes Today?

It often pays to check up on the condition of your boiler tubes, noting those that may soon need replacement.

We can supply straight or bent tubes of any size, for any type of boiler. Fast service—mill prices.

BOILER TUBE CO.
of America
World's Fastest Boiler Tube Service
Main Office and Works:
3125 Preble Ave., Pittsburgh, Pa.

TYLER BOILER TUBES

Where water conditions are favorable, we recommend our lap-welded steel tubes. For unfavorable water conditions we suggest our charcoal iron tubes.

Let us know your requirements.

TYLER TUBE AND PIPE CO., Washington, Penn.

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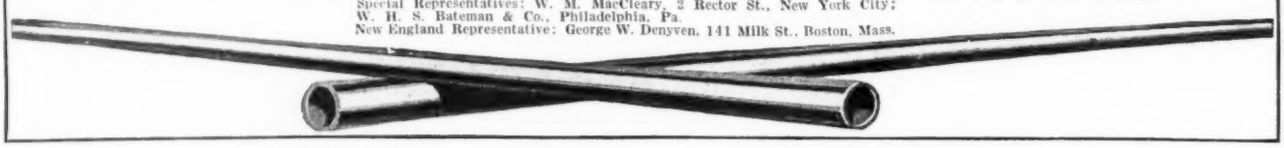
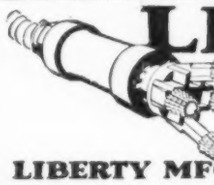




LIBERTY CLEANERS

for all sizes and types of tubes

LIBERTY MFG. CO., JEANNETTE, PA.

RUTHS STEAM ACCUMULATOR

RUTHS ACCUMULATOR CO., INC.
292 Madison Ave., New York

VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU BOIS PA. OFFICES IN THIRTY CITIES

Webster Bldg., DuBois, Penna.

Soot Cleaners For All Types of Water Tube and Return Tubular Boilers, Super-Heaters and Economizers.

Lagonda Tube Cleaners

Tube Cutters, Reseating Machines
The LAGONDA MANUFACTURING CO., SPRINGFIELD, O.

COLD DRAFTS
can't break
SONDERGLASS
"The Unbreakable Boiler Gage Glass"

No sudden temperature change affects SONDERGLASS. It is made to resist them by the fusion of two semi-metallic substances of different expansibility into a clear pressure resisting tube.

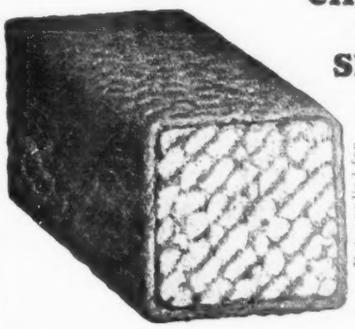
Far Outlasts Other Brands

because of its extreme durability it is the cheapest gage glass you can buy. Stands up under boiler pressures to 400 lb.

Reflecting SONDERGLASS
Made for the dark places. Shows the water level in RED clearly against a WHITE enamel background.

A. W. Chesterton Co.
64 India St., Boston, Mass.

CHESTERTON'S NUMBER SIXTY FOUR

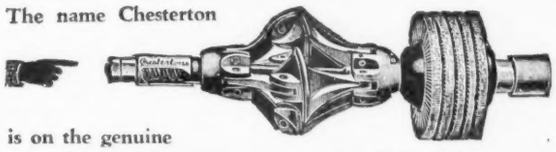


Pat. applied for

The diagonal construction insures compressibility and long service. Slippage is allowed and hardening is prevented by the special graphite packing between the diagonal plies. It is all asbestos — nothing to burn.

A decided improvement over the old style folded packing.

The name Chesterton



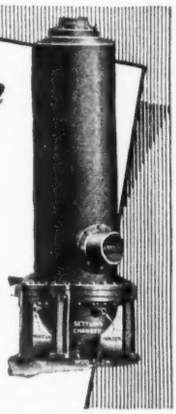
is on the genuine

For the Removal of Soot—
The "COMBINATION" Scraper and Brush

Some dealers offer an imitation that costs them a little less—
But where do you come in?

A. W. Chesterton Company or Advance Packing & Supply Company
64 India St., Boston, Mass. 808 Washington Blvd., Chicago, Ill.

Patterson-Berryman
Feed Water Heaters and Purifiers



will heat the feed water from 40° F. to from 200 to 212° F. and remove impurities.

They reduce fuel cost, increase the steaming capacities and life of the boilers and show the highest waterheating efficiency. Backed by 47 years' experience. Sold on 60 days' trial.

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The Patterson-Kelley Co.
100 Park Ave., New York

GREEN'S FUEL ECONOMIZERS

They will save from 10 to 15 per cent on your coal bill by recovering a large part of the heat now being wasted up your stack.

Millions of boiler horsepower to prove this saving. Get all the facts.

THE GREEN FUEL ECONOMIZER CO.
BEACON, N.Y.

Jungström AIR PREHEATER

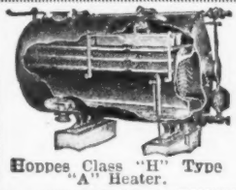
Recovers 70% stack heat, raises CO_2, improves combustion—*Bulletin on request.*

THE AIR PREHEATER CORPORATION
25 Broadway, N. Y. Works, Wellsville, N. Y

THERMIX AIR HEATER and STREAM LINE STACK

Save waste heat in flue gas with a Thermix.
Save power for mechanical draft with a Stream Line Stack.
SEE SWEET'S CATALOG *Write for Catalog.* SEE A.S.M.E. CATALOG
PRAT-DANIEL CORP., 101 Park Ave., New York, N. Y.

WATER SOFTENERS & FILTERS
Hot — Cold — Intermittent — Zeolite; Pressure — Gravity
Complete Engineering Service
GRAVER *Corporation* Founded 1857
855 Todd Avenue East Chicago, Indiana



Hoppes Class "H" Type "A" Heater.

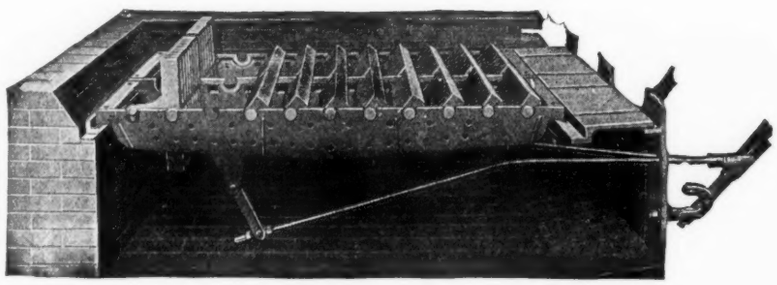
A large heater in a small space

Catalog No. 85 tells about the full line

The Hoppes Manufacturing Co.
19 Larch St., Springfield, O.

KELLY GRATES GOSHEN IND

Rocking and Dumping Grates



Give it Air!

Kelly Rocking and Dumping Grates are designed for complete combustion of any grade of coal. Because of their simple operation, air spaces can always be kept open, causing uniform combustion over the whole area with its attendant advantages.

The labor of firing, with a Kelly Grate is reduced 50%. Forward cleaning of fires is done away with. Ash is sifted and clinkers dumped by means of levers at boiler fronts.

Install Kelly Rocking and Dumping Grates under your boiler and watch the steam pressure go up and the fuel and labor costs go down.

Write for Catalog and send furnace area for price.

The Kelly Foundry & Machine Co.,
614 Ninth Street Est.1887 Goshen, Indiana

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BALL BEARING
Clements Cadillac
PORTABLE ELECTRIC
BLOWER

Removes dust and dirt from electric windings with blast of *dry air*. Correct pressure for this service prevents shorts and burnouts. Reduces fire risk and maintenance cost. Hundreds of uses in power plant or factory. Norma Ball Bearings; no oiling. Write for descriptive folder and trial offer.

CLEMENTS MFG. CO.
629 Fulton Street, Chicago, Illinois

Increased Boiler Rating With Low Priced Fuel

A result of Coppus Forced Draft Blowers

DO NOT CHANGE YOUR CHIMNEY OR PUT IN ANOTHER BOILER BEFORE READING BOOKLET NO. 145.

REGISTERED COPPUS U.S. PAT. OFFICE ENGINEERING CORPORATION
350 PARK AVE. WORCESTER, MASS.

CENTRIFUGAL TURBO BOILER FEED PUMPS • STEAM TURBINES • MINE VENTILATING BLOWERS

FOSTER WHEELER

FRACTIONATING TOWERS HEAT EXCHANGERS
STEAM JET AIR PUMPS SUPERHEATERS
TUBE STILLS VACUUM PUMPS
WATER COOLED FURNACE SURFACES
BRASS AND COPPER TUBING AND PIPE

AERO UNIT COAL PULVERIZERS
AIR HEATERS CENTRIFUGAL PUMPS
CONDENSERS COOLING TOWERS
ECONOMIZERS EVAPORATORS
EXPANSION JOINTS FEED WATER HEATERS

FOSTER WHEELER CORPORATION, 165 Broadway, New York
A consolidation of Power Specialty Co., and Wheeler Condenser & Engineering Co.
Works: Carteret, N. J.; Dansville, N. Y.; Newburgh, N. Y.

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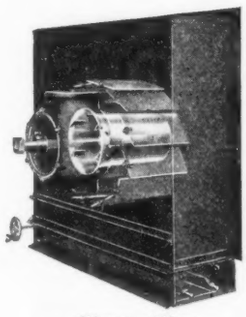
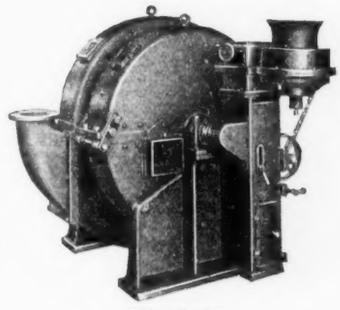
The Riley Atrita Unit Pulverizer and Burner



Phantom View
Riley Flare Type Burner

When you can obtain a load range of from ten to one, that is real load range. Wide load range is one of the distinctive features of the Atrita Unit Pulverizer and the Riley Flare Type Burner. Inherent characteristics make this possible. For instance, if extremely low ratings are desired, secondary air is shut off from the burner and as the Atrita takes such a small amount of the air required for combustion through the machine, exceedingly low ratings can be obtained efficiently. The possibilities along this line are shown by the fact that combustion was maintained in the open air with the Riley Atrita Unit Pulverizer and Burner.



Riley Atrita
Unit Pulverizer

Higher ratings depend more upon the features of the burner. The Riley Flare Type Burner with its specially constructed mixing chamber, its distributing vanes and adjustable coal spreader produces an even distribution at the burner nozzle and a thorough mixing of coal and air. Naturally flame propagation is rapid, and high ratings can be carried.

The past year has seen some really important developments in Riley Pulverized Coal Equipment. It will prove worth your while to request detailed information about them. *Write us.*

Riley Stoker Corporation

RILEY STOKER CORPORATION
9 Neponset Street, WORCESTER, MASS., U. S. A.

"RILEY" Underfeed Stokers
"JONES" Underfeed Stokers
"HARRINGTON" Traveling Grate Stokers
"MURPHY" Automatic Furnaces
Pulverized Coal Installations

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT SEATTLE
CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER CHARLOTTE DALLAS HOUSTON NEW ORLEANS

Riley Engineering and Supply Co., Ltd., Toronto
Riley Stoker Co., Ltd., London

The Taylor Stoker

Gets more heat from a pound of coal than any other Combustion System

A well illustrated catalog written for the Executive as well as the Engineer gladly sent on request

American Engineering Company, Philadelphia

Manufactured in Canada and sold by AFFILIATED ENGINEERING COMPANIES, LTD. Principal Sales Office: Southam Bldg., Montreal, Quebec.

PULVERZONE

Combining three coal burning methods in one: Pulverized coal burning, spread method and coking method.

Also CoKal Hand Feed Stoker
CoKal Hopper Feed Stoker
CoKal Power Feed Stoker
CoKal Semi-mechanical Stoker
CoKal Full mechanical Stoker

Complete automatic control, electric, hydraulic or steam.

CoKal Stoker Corporation
1014 Wrigley Building, Chicago

Northwestern Automatic Control
Pressure and Combustion

THE CONSULTING ENGINEERING CO.
Fulton Bldg., Pittsburgh, Pa.

Mettler Entrained Combustion Gas Burners
FOR ALL Purposes Kinds of gas Pressures
406 S. Main St. LEE B. METTLER, CO. Los Angeles, Cal.

COAL—GAS—OIL BURNERS
PEABODY
112 EAST 42nd ST. NEW YORK

Hammel Oil Burning System

Our engineering department is available for consultation on your oil burning requirements. Write us for Bulletins covering our Oil Burning System, Oil Burners, Oil Heaters, Oil Pump Sets and Accessories

See page advertisement in Nov. 29 issue.

HAMMEL OIL BURNING EQUIPMENT CO.
409 Pine St., Providence, R. I.

A new CLARAGE
High Speed Blower-for forced Draft

New design shows higher efficiency over wide operating range. Electrically welded wheel for greater safety. Ball Bearings with Alemite attachment standard equipment. Made all sizes. Write for details.

CLARAGE FAN COMPANY, Kalamazoo, Mich.

NEEMES

GRATES AND STOKERS
Shaking and Dumping Types Hand-Operated
Send for bulletins
Neemes Foundry, Inc., Troy, N. Y.

"Buffalo" FANS
for mechanical draft heating and ventilating
Buffalo Forge Co.
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CYCLONE GRATES
Make *all* of your fuel count in power.
Write for Full Details.
CYCLONE GRATE BAR CO.
9 Grimes St., Buffalo, New York

COEN
for Increased Steam Production

MECHANICAL OIL BURNERS & IMPROVED AIR REGISTERS

Wide flexibility. Ideal flame control. A 100% load range without changing burner tip. Increased output of any type of boiler. Write for Bulletin "M."

COEN COMPANY, Inc., 50 Church St., New York—112 Market St., San Francisco

CUSTODIS CHIMNEYS

Alphons Custodis Chimney Construction Co.
95 Nassau Street, New York
Marquette Bldg., Chicago

Perforated Radial Brick Chimneys

BUILDERS OF THE TALLEST AND LARGEST CHIMNEYS IN THE WORLD

Anaconda Copper Mining Co., Anaconda, Mont., Height 585 ft. above grade. Top diam. 60 ft. Chimneys of all sizes, for all purposes, for boilers, furnaces, chemical plants, destructors, etc. Experts in repairing chimneys. Lightning rods installed and repaired. Specifications, plans, designs and data furnished free upon request.

Send for free booklet P4 "How to Determine The Proper Size of Chimney," and "A Treatise on Calculation of Stresses in Brick Chimneys."

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FACTS About Firebrick Joints

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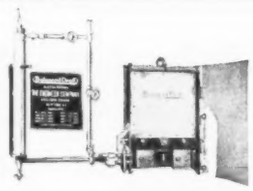

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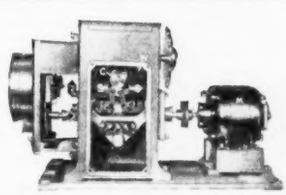

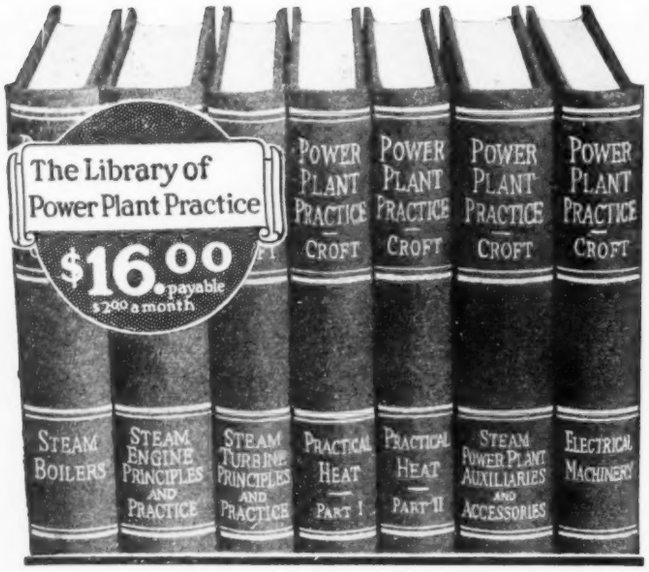
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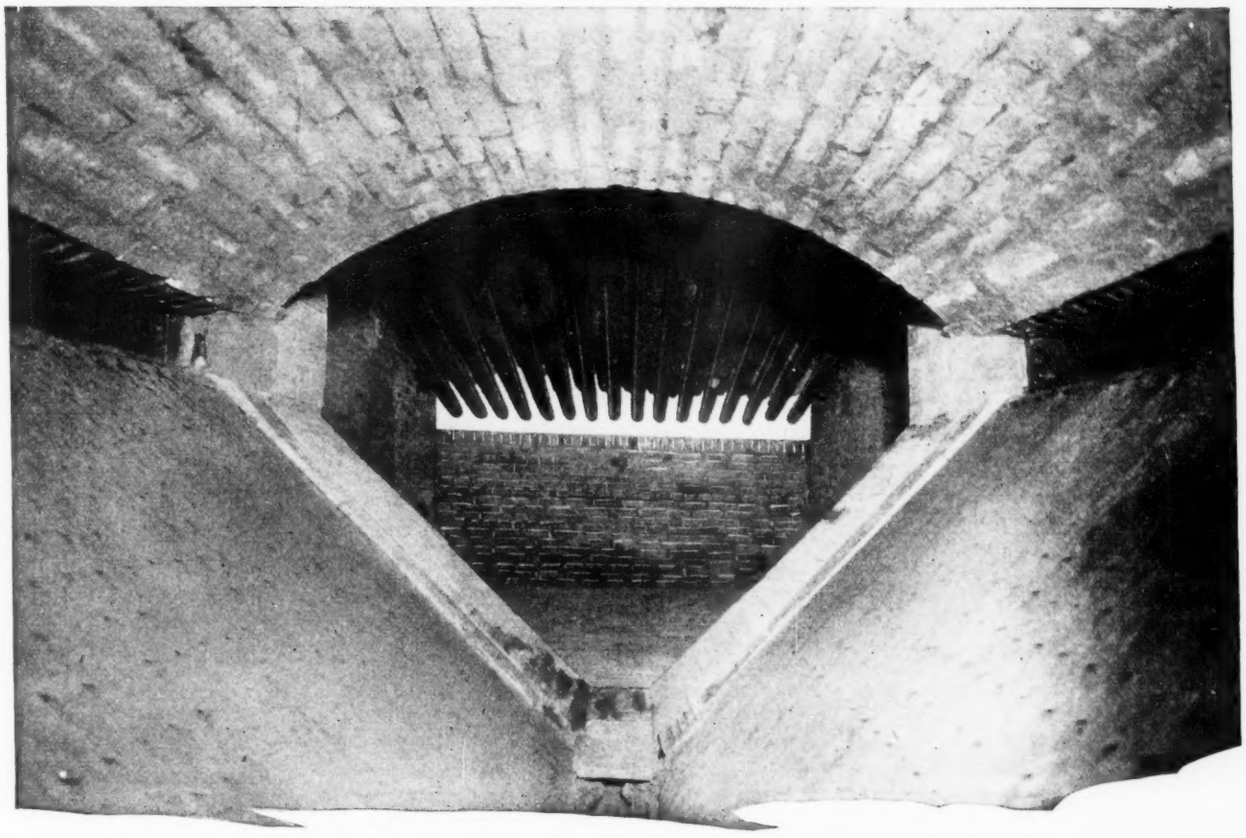

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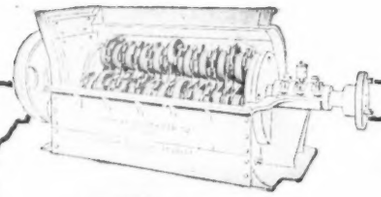

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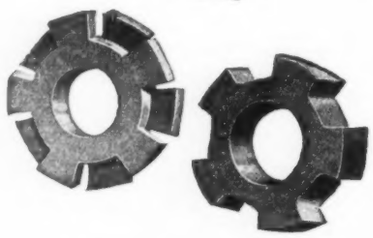

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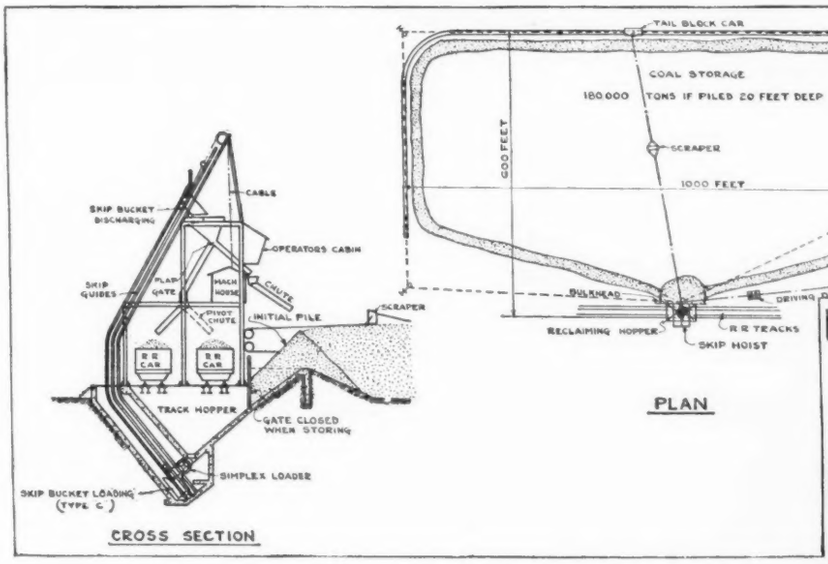
CABLE DRAG SCRAPER
for Coal Storage



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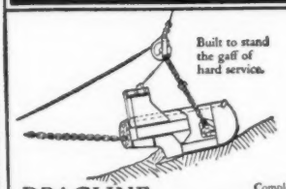

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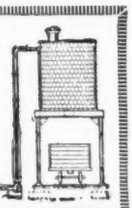

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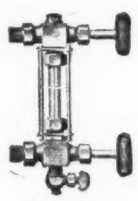

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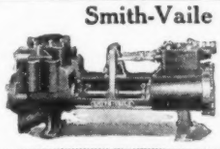

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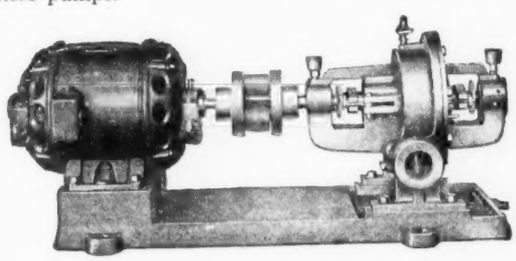

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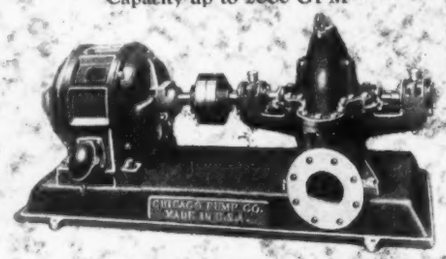

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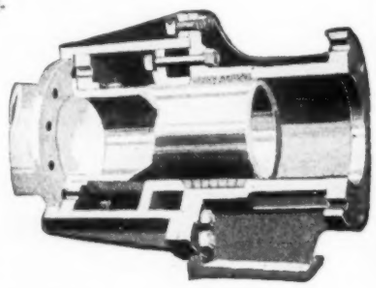

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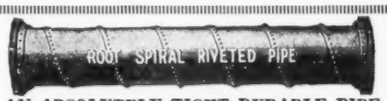

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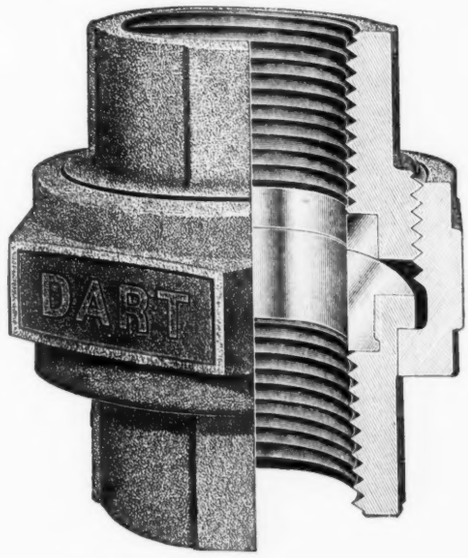

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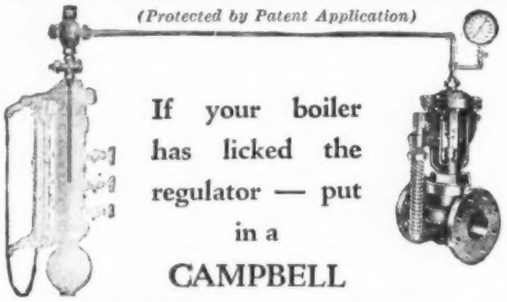

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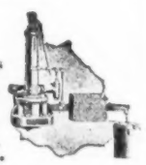

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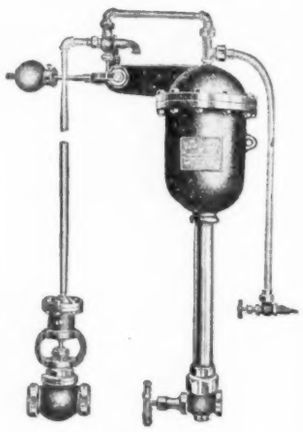

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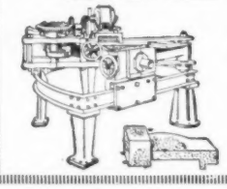

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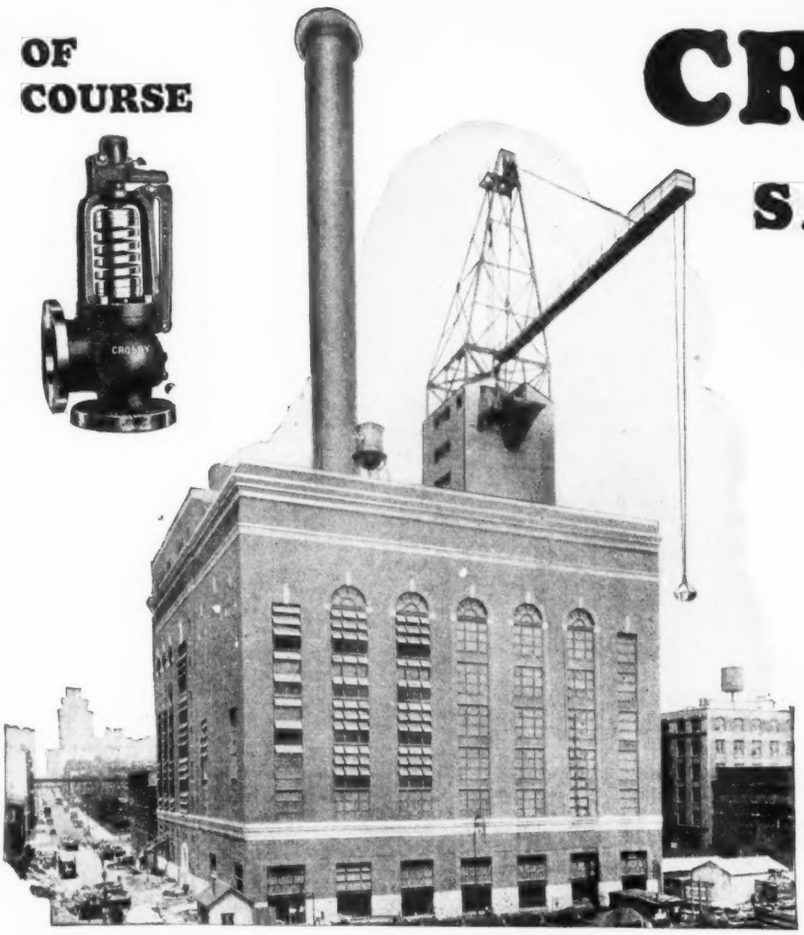

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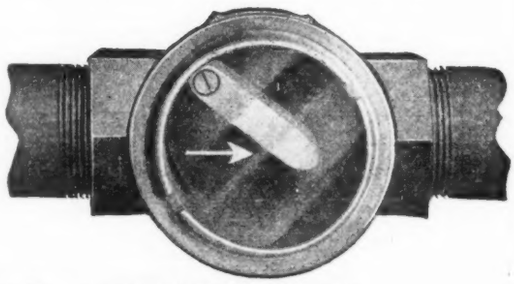

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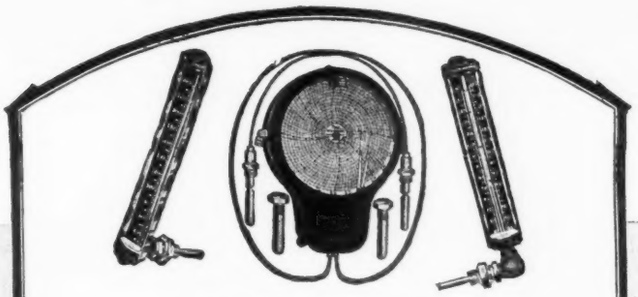

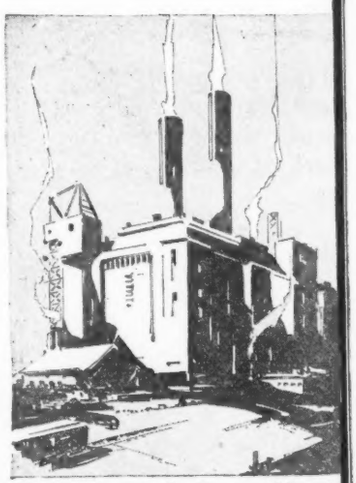

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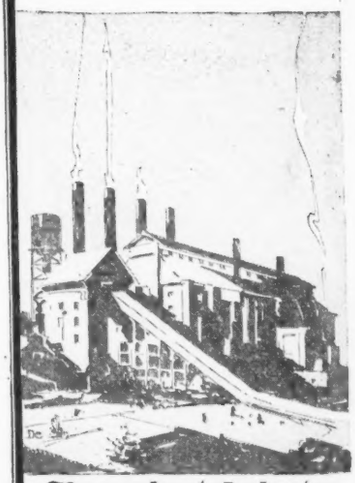

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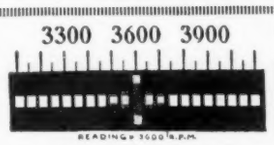

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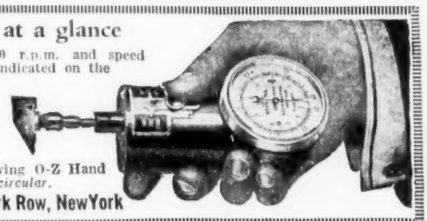

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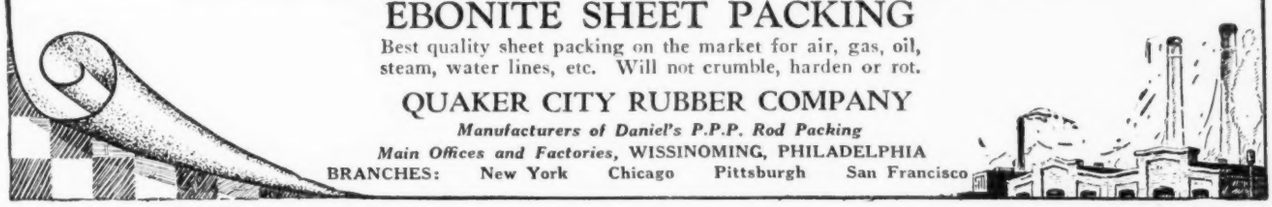

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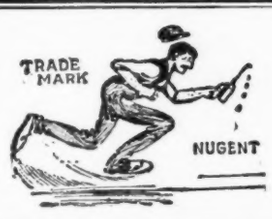

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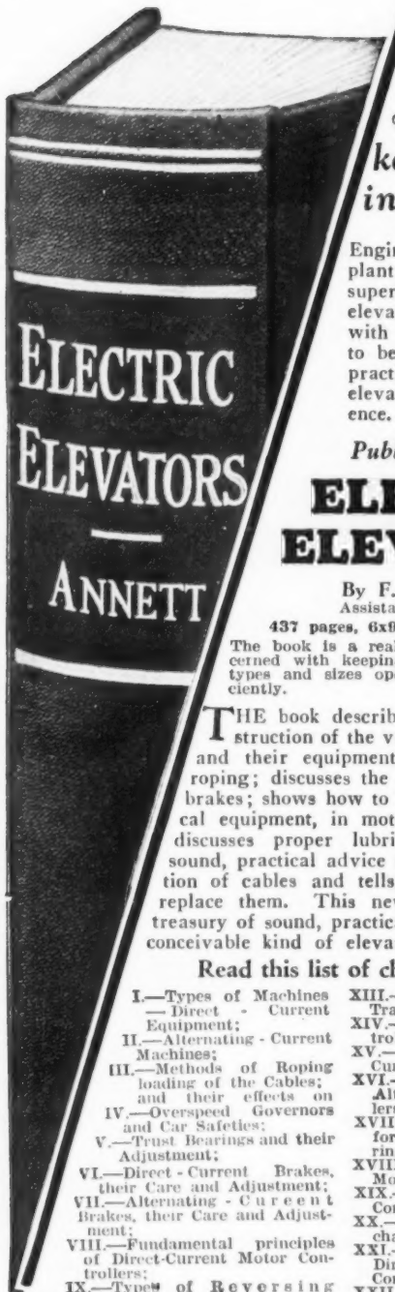

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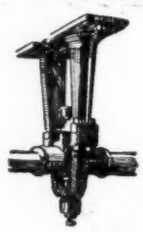

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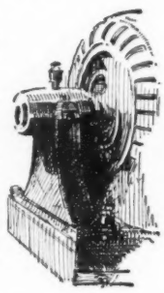

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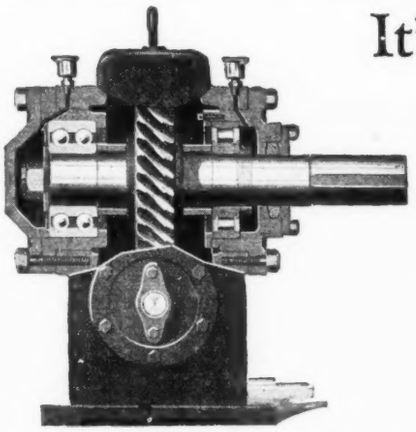

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Philadelphia Units are Dust, Dirt, Moisture and Accident proof.

They eliminate belts, chains, pulleys, etc., and require no attention in service, except occasional oiling.

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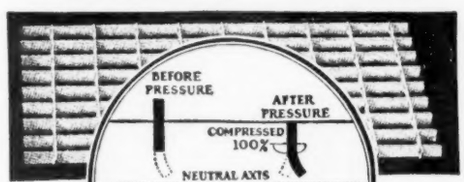

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First, there is a right-twist lock in every other bar.

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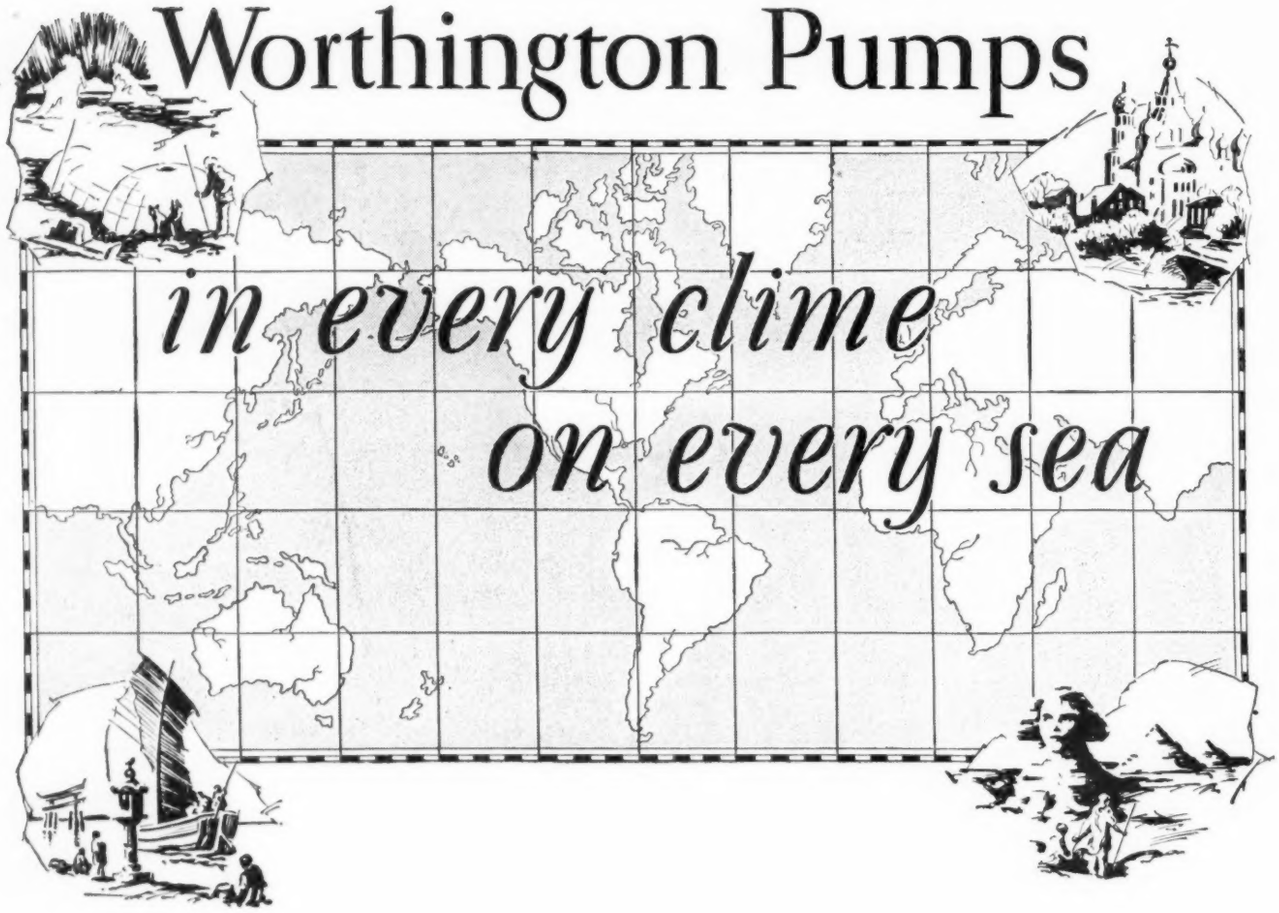

FROM the equator to inside the polar circles, you will find Worthington Pumps giving splendid service.

In European industrial centers, Worthington Pumps are as well known as at home.

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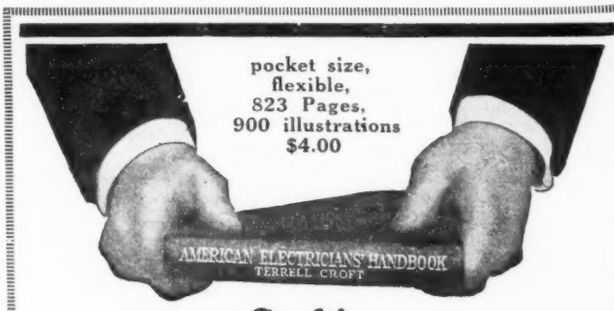

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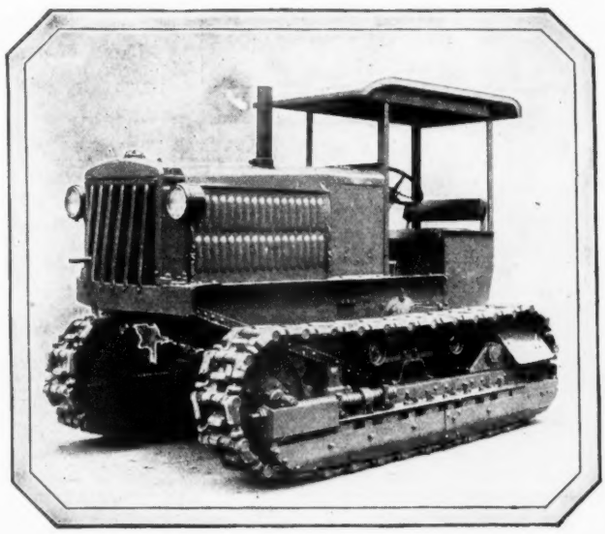

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Fuels, soaps, oils, waters and
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then go ahead!

The building of a new power plant, the problem of increasing present plant efficiency and hundreds of others of your miscellaneous power plant problems demand facts first before you make expensive contemplated changes.

The professional consultants advertising in this Directory can assist you materially in finding facts first about your power problems, that may result in your saving hundreds of dollars.

Consult them!

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STATIONARY power plant engineer, 16 years' practical experience on land and sea, desires position as assistant stationary engineer; experience covers steam- and Diesel-engines. PW-450, Power, Tenth Ave. at 36th St., New York.

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SUPERINTENDENT of construction as power, mechanical and electrical engineer; practical and technical; expert on modern construction and equipment, utility and industrial power plants. PW-449, Power, 1600 Arch St., Phila., Pa.

United States

MECHANICAL engineer, power plant and manufacturing experience. 34, expert on combustion of low grade fuels, plant heat balance, operation and maintenance. Public utility experience and 4 years chief of large industrial. Familiar with high tension transmission, plant interconnections, and load dispatching over large territories. Desire new connection with opportunities. Good record of economy. References. PW-454, Power, 1600 Arch St., Phila., Pa.

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Experienced, Energetic Live Wire Salesman

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For sale of storage water heaters. Many important centers open for a well-made moderate priced standard equipment. AW-453, Power, Tenth Ave. at 36th St., New York.

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G-23

Diesel Engine

1—150 Hp. Fairbanks-Morse Diesel Engine direct connected to 125 kva., 2 ph., 60 cy., 230 v., 257 r.p.m. Generator—Set up to run on stand by service only, but never used—Perfect condition.

FS-440, Power
Tenth Ave. at 36th St., New York City

FOR SALE

SKINNER ENGINE

with 60 Kva. Western Electric 240 Volt Generator Belted Exciter, Switchboard, perfect condition. Seen running.

AKRON TOWEL SUPPLY COMPANY
Akron, Ohio

USED POWER EQUIPMENT

Released from service by a number of public utility companies

Electrical—Hydraulic—Mechanical

Our summary contains a complete list of equipment under above classification

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Phoenix Utility Co., 2 Rector St., New York City

Blaw-Knox Wants Grating Distributor

Are you the man or the firm who can make a success of selling Blaw-Knox Security Steel Grating and Open Flooring in your locality? This grating has five points of primary advantages over others in the market and is extremely easy to sell as its advantages are immediately apparent. It is extra strong, electroforged in one piece, has positive non-slip features, gives maximum lighting and ventilation and can be 100% effectively galvanized or painted. This new grating is causing a sensation among buyers. The Blaw-Knox Company, well known manufacturers of steel specialties, have a few good territories open for distributors who are in a position to sell engineers, architects, contractors, industrial plants, etc. Preliminary correspondence is invited. Tell us what lines you now handle, the extent of your organization, and the territory you cover.

Blaw-Knox Company
Pittsburgh, Pa.

WANTED

WANTED

Generator

1—belt or rope drive, 575 to 600 KVA—AC, 80% PF, 60 cycles, 3 phase, 550 volts.

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1600 Arch St., Philadelphia, Pa.

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—to help you get what you want.
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For Every Business Want

"Think SEARCHLIGHT First"

G-36

The choice of experienced buyers for more than 33 years!

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Like New in
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Save the difference in price in your next installation—TRY ONE!

They are shipped on approval
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New 80-page illustrated Monthly Bargain Sheet listing the largest stock of Hi-Grade-Rebuilt Motors, Generators, Transformers, Meters, etc., in America at prices that show a real saving.

Write, phone or wire today.

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Rebuilders of Hi-Grade Electrical Machinery Since 1893

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1—3,000 kw. G. E. Turbo.
2—1,000 kw. G. E. Turbo.
1—780 kw. Westgh. Turbo.
2—600 kw. New G. E. Turbo.
1—300 kw. Westgh. Turbo.
2—300 kw. G. E. Turbo.
1—90 kw. Terry-Allis.
1—62½ kw. Westgh. Turbo.
3—85 kw. Allis-Chalmers. to Diesel Engines.
100 kw., 125v. D.C. to Ames.
150 kw., 125 v. D.C. to Ames Unaflow.
300 kw., 250 v. D.C. Westgh. Turbo.
50 kw., A.C. Ames.
125 kw. A.C. Hamilton.
125 kw., A.C. Harrisburg.
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312 kva., NEW General Elec.

Turbo Generators, Various Sizes; Also large stock Transformers, Engine Driven Units, Motor Generators, Motors, Dynamos of all descriptions.

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2 New. Type H Form QT No. 1644996. Capacity 75 K.V.A. Cycle 60. Oil 115 gal. Volts 2400/120. O.S. K1747625. General Electric.

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3 Phase, 60 Cycle, 2300/600/480/240 Volts

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At the sacrifice prices we are quoting on these engines, many of which are New, others are guaranteed equal to new.

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6x7½-in. Dutton, (1) new ..... 8 H. P.
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Horizontal (Automatic)

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NEW AND USED

EVERY motor sold is guaranteed. Write for our low prices on your requirements.

SLIP RING MOTORS

Hp.	Make	Ph.	Cy.	Volts	Rpm.
300	Allis-Chal.	3	60	220-440	870
250	Fair.-Morse	3	60	220-440	600
175	Allis-Chal.	3	60	550	600
100	Westg. (C.W.)	3	60	550	600
100	Westg. (C.W.)	2	60	220	600
100	Westg. (C.W.)	3	60	220-440	600

Other slip-ring motors down to ¼ hp.

SQUIRREL CAGE MOTORS

150	G. E.	3	25	440	375
150	G. E. (K.T.)	3	60	2200	870
100	Cr.-Wh.	3	60	220-440	1750
75	Cr.-Wh.	3	60	220-440	1160
50	Gen. Elec.	3	60	220-440	900

Other squirrel cage motors down to ¼ hp.

DIRECT CURRENT MOTORS
All 220 volts-230 volts

Hp.	Make	Speed
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100	Sprague (C)	550/1100
60	Westg. (S)	920
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Write for complete stock list.

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Mail or wire specifications of your requirements

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3—200 HP. Oil Engines NEW
750 Kva.- Unaflow Eng. Set, A. C.
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Each having 312 Bronze Tubes 1 in. dia. 23 ft. 8 in. long. (PRAC. NEW) 100 Press.
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12500-9375-6250-2500 Kva.
2700 ft. Air Comp. Dir. Con. Motor TURBO with surface cond. and auxl's.
750 and 937 Kva. Mixed Press Turbos
BOILERS
1—New 1001 HP., 200 lb.
ROSS POWER EQUIPMENT CO.
Indianapolis, Ind.

RANDLE
OFFERS BIG BARGAINS
IN
Used and Rebuilt Engine Generator Sets, Turbo Generator Sets, Motors, Rotary Converters, Generators, Motor Generator Sets, Engines, Boilers, Steam and Electric Machinery of all kinds also Machine Tools. Send for our new machinery list. Yours for the asking.

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Unusual Opportunities

1—250 kva., 2 ph., 60 cycle, 240 v., 900 r.p.m. Westinghouse Generator, geared to Westinghouse Steam Turbine non-condensing. Practically new.

1—45 hp. Burk D.C. Type AM-7, 230 v., 132 amp., 1,200 r.p.m. shunt wound Serial 516839, direct connected to 1 Burk kva. A.C. Generator, Type AC8-35, 230 v., 132 A, 60 cycle, 3 phase, Serial 50836.

Also large stock A.C. and D.C. Generators and Motors. All priced low for quick sale. Advise your requirements.

Henry A. Hitner's Sons Co.
4501 Richmond St., Philadelphia, Pa.

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Water Wheel Governors

Will sell cheap, two Lombard Type N Governors, complete with pumps and air tanks.

Mississippi Valley Public Service Company
Winona, Minn.

Prices Reduced 33-1/3%
BOILER FEED PUMPS

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14-in. and 20x10¾x10-in. Worthington.
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9-in. and 14x8½x15-in. Worthington, O.S.C.P.
14x8x12-in. Eppinger Carpenter, O.S.C.P.
12x8x12-in. Gardner, O.S.C.P. Bronze Plungers.
12x7x12-in. Worthington, O.S.C.P., 200 lbs.
12x6½x12-in. Platt, O.S.C.P., 200 lbs. pressure.
10x6x12-in. O.S.E.P. Worthington, 300 lbs.

PISTON TYPE BRASS FITTED

11-in. and 20x10x15-in. Worthington.
5¼x3½x5-in. Worthington, brass ftd.
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Wickes Machinery Co.
385 Claremont Ave., Jersey City, N. J.

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599 cu.ft. capacity Ingersoll Rand Type XB2, size 16x10x14 in., two-stage motor driven Air Compressor.

GENERATING UNIT

125 kw., 100% power factor General Electric, 3 phase, 60 cycle, 220/440 volt Generator, direct connected to Harrisburg Fleming automatic Steam Engine.

THE O'BRIEN MACHINERY CO.
113 NORTH THIRD ST.
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A. C. UNITS, 440/220 VOLTS

375 kva. Al. Chal. Alternator dir. con. 20x36 Al. Chal. Corliss Engine; new 1919; seen operating, $5,500.

375 kva. G. E. Turbine (bleeder type); Exciter and Condenser; 3 years' service; seen operating, $4,500.

250 kva. Wghse.; dir. con. 21x22 Skinner Uniflow Engine; new 1923, seen operating, $5,500.

200 kva. Al. Chal.; dir. con. 16x36 Al. Chal. Corliss Engine; like new; seen operating, $3,500.

160 kva. G. E. Alternator dir. con. 18x24 Hamilton Corliss; practically new; seen operating, $3,000.

150 kva. G. E.; Ames Uniflow; new 1921; seen operating, $3,750.

1—Wheeler Surface Condenser, 755 sq.ft., $800.

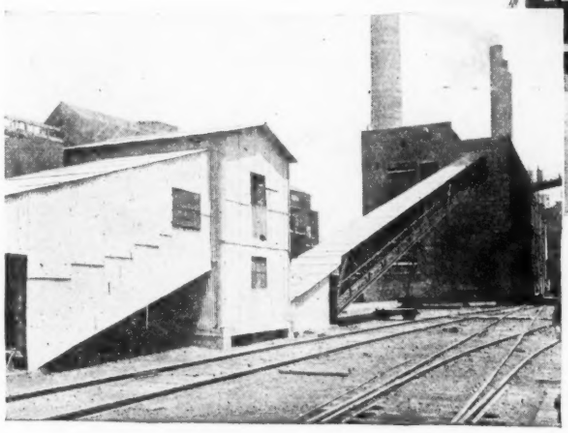
POWER PLANT EQUIPMENT CO., INC.
39-41 Cortlandt Street, New York City, N. Y.

You Want What You Want When You Want it

—and Good Used Equipment may often meet an urgent temporary need—or a permanent one.

Watch the Searchlight Section for Equipment Opportunities

The view showing the conveyor galleries is that of the E. A. Staley plant. The other is the Des Moines, Iowa, Station of the Illinois Power Company.



Two of the Finest Power Plants In the *Middle West* ROBINS Equipped

ROBINS engineers designed and equipped the coal handling system in these two middle western power plants—

Des Moines, Iowa, Station
Illinois Power Company
E. A. Staley Mfg., Co.
Decatur, Illinois

Only through the application of wide experience can practical and economical coal handling systems be assured. Robins engineers have this experience.

Then, the handling of coal generally involves idlers, belting, elevators, trippers, grizzlies, feeders, crushers and weigh larries—all of which Robins makes and can provide.

Our nearest office will be glad to send an engineer to make a study of your coal handling system and suggest improvements wherever possible.

Ash Handling Is Important.

Robins has available a number of proven methods for disposing of ashes. Of principal interest are the full and semi-automatic Skip-Hoists. Send for literature.

ROBINS CONVEYING BELT CO.
15 Park Row, New York City
Chicago, Boston, Philadelphia
Pittsburgh, Los Angeles
Agents in other principal cities

Conveying and Elevating Equipment
Ash Handling Systems
Crushing and Screening Systems

MATERIAL HANDLING
ROBINS
EQUIPMENT

ALFIT

TRADE MARK REGISTERED

The dough-like

ALL METALLIC PACKING

under pressure forms a metal bearing. It remains from beginning to end elastic, greasy and does not burn out.

NO LEAKAGE *NO FRICTION* *NO WASTE*

One of the largest steel companies writes: "ALFIT IS VERY MUCH BETTER THAN ANYTHING WE EVER USED"

ALFIT PACKING CO., Inc.
299 Broadway
NEW YORK

Distributors: Write for territory.

Conneaut Plastic Metallic Packing

eliminates the size proposition

Covers an extremely wide field of application and gives dependable service. Lasts for years.

It is exceptionally suited for use on piston rods, valve stems, rotary pumps handling water, oils or chemicals.

Ask for bulletin.

The Conneaut Packing Co.
CONNEAUT, OHIO

VALBESTINE

A Garco Product

For packing Valve Stems and small rods

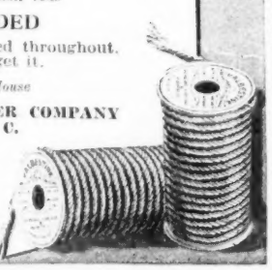
TWISTED or BRAIDED

High flash lubricant and graphited throughout. Pack with VALBESTINE and forget it.

From your local Supply House

GENERAL ASBESTOS & RUBBER COMPANY
North Charleston, S. C.

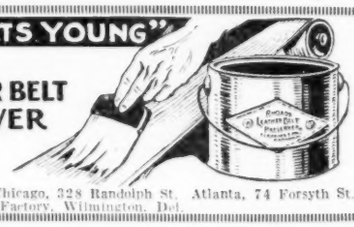
GARCO ASBESTOS PACKINGS
TEXTILES
BRAKE LINING



"IT KEEPS BELTS YOUNG"

RHOADS LEATHER BELT PRESERVER

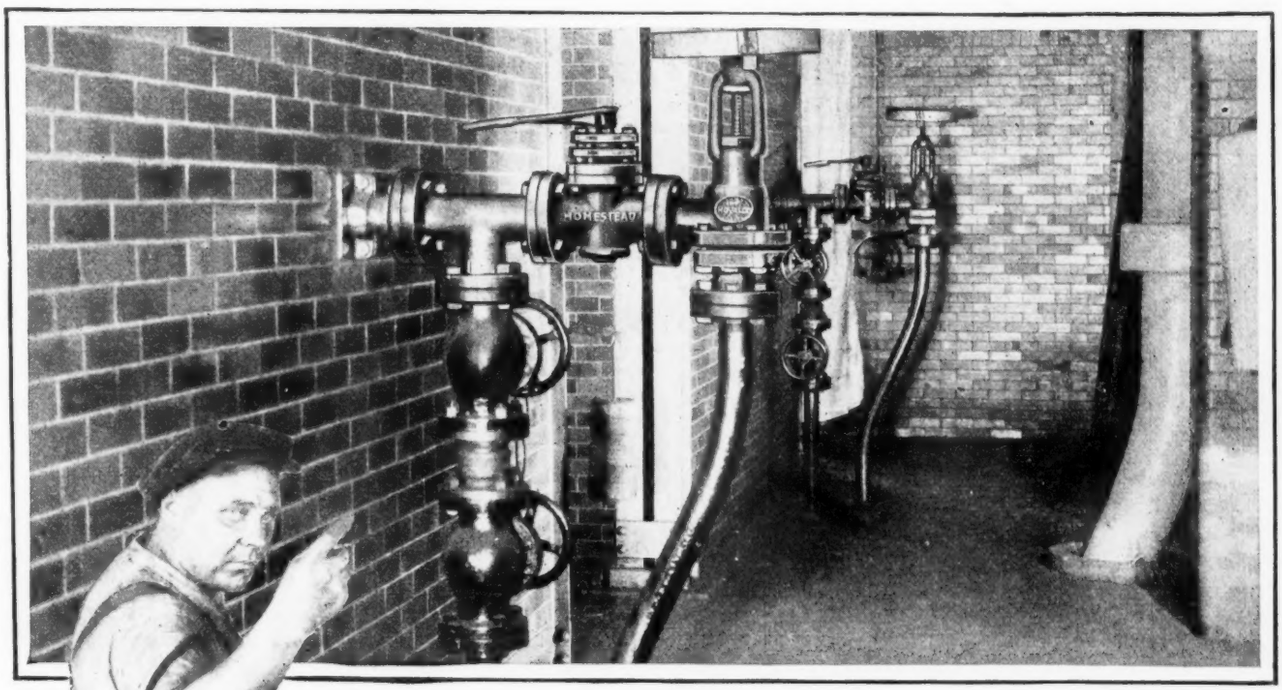
J. E. RHOADS & SONS
Makers of Tannate Leather Belting
Philadelphia, 11 N. 6th St.
New York, 108 Beekman St. Chicago, 328 Randolph St. Atlanta, 74 Forsyth St.
Cleveland, 1278 W. 9th St. Factory, Wilmington, Del.



GARLOCK

DON'T BUY PACKING
PURCHASE PACKING
SERVICE
GARLOCK SELLS IT

The Standard Packing of the World



"Do you think General Motors would buy a poor valve?"

Quarter-Turn Val

Quarter Turn Val symbolizes the men who best know the many points of superiority found in Homestead Valves. He serves them.

The Hovalco—Homestead Combination Blow-Off Valves pictured are in service in the General Motors Building, Detroit.

This cast steel combination blow-off valve was designed to meet the severe tests required by steam boiler practice. The valve bodies are of steel. The seat and disc in the Hovalco Valve are of monel metal. So is the plug in the Homestead-Quarter Turn Valve. The combination is furnished for 250 lbs. and 400 lbs.

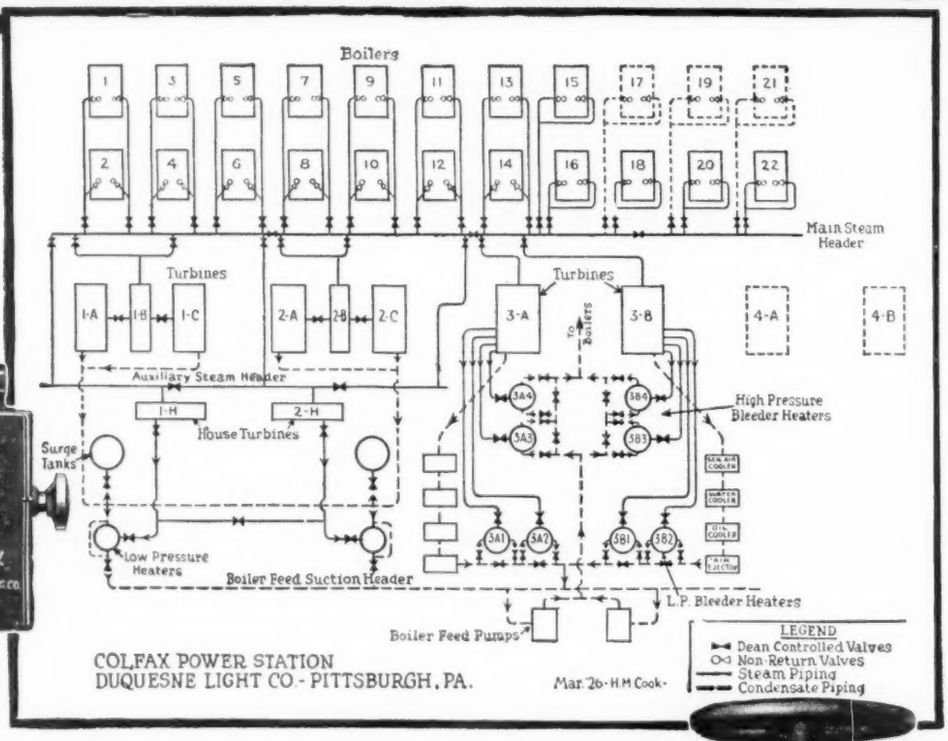
Homestead Valve Manufacturing Company, Homestead, Pa.

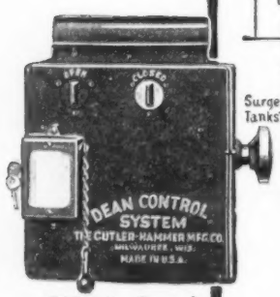
HOMESTEAD VALVES

QUARTER TURN VALVES:
STRAIGHT WAY
THREE WAY
FOUR WAY
LUBRICATED TYPE
ROUND OPENING REFINERY

PROTECTED SEAT VALVES:
HYDRAULIC (B & O. PAT.) OPERATING
REMOTE CONTROL
GLOBE
ROSS AIR SHUT-OFF VALVE
HOVALCO BLOW-OFF VALVE

101 C-H Valve Control Units





C-H Valve Control Units can be placed wherever convenient, or safe—can be grouped on a panel if desired.

—make this modern plant efficient, safe

C-H Valve Operating Units can be installed on any valve—new or already in service—usually without shutting down the line.

See C-H Valve Control at the Chicago Power Show Booths 110, 111, 112

ONE of the leading power plants in the country operates 101 valves with C-H Motor Operating Valve Units. This endorsement by such extensive use followed the rigid test of performance. C-H Valve Control System proved more efficient, safer than hand operation could possibly be.

Any valve, in any location, responds instantly to the touch of a finger to the control station which is placed in a convenient, safe spot. Valve operation is a matter of seconds and where needed, "fool-proof" interlocks can be arranged for following any desired sequence of valve operation.

Isn't a thorough investigation of such valve control well worth while? Just write for the booklet "Modern Valve Control Practice".

The CUTLER-HAMMER Mfg. Co.

Pioneer Manufacturers of Electric Control Apparatus

1201 St. Paul Avenue - MILWAUKEE, WISCONSIN

CUTLER HAMMER

Dean Valve Control System

Typical survey sheets containing data on basis of which proper treatment of raw feed water is prescribed.

CHICAGO CHEMICAL COMPANY — WATER TREATING SURVEY

Date

Plant of
Address
Submitted to
Title
Type and make of softening plant
Filter location and type

INTERMITTENT

Capacity tanks gross Net
Time required to fill
Lime in
Coagulant in
Soda ash in
Time of agitation
Time for settling Use 24 hrs.
No. tanks
How often are filters washed?
How often are tanks sludged?

CONTINUOUS (24 hr. schedule)

Hot or cold process?
Rated capacity
Actual amount produced
Actual setting
Time for settling
Can chemicals be fed separately?
Is chemical feed consistent?
Chemical charge interval
Type of chemical feeder
Type of chemical feeder
How often are filters washed?
How often are tanks sludged?

Type of condensers
At what point if any does raw water pollute treated water?
Is this condition permanent? Consistent? Per cent oil in return
Is raw water pre-heated? Avg. temperature raw Treated

RAW WATER

Source Turbidity before treating After
Analysis M. OH H CO_2 Cl Ca Mg SO4 Fe CO_2 Cl

TREATED WATER

Amount of chemicals in pounds.

Analysis H. P. M. OH CO3 N Lime(kind) Soda Ash Coagulant (kind)
Test #1.
2.
3.
4.

BOILER ROOM OPERATION

Per cent make up Blow down interval Amount blow down
Is concentration test made? How? Actual boiler rating
Type, make, and no. boilers Steam used for Heater Temperature
Is load steady? Washed out
How often boilers turbined? Average tube loss
How often boilers of scale Corrosion? Pitting?
Type and thickness of scale How often cleaned?
Any trouble with foaming? Valuable
Any trouble with deposit Thickness Deposits
Feed lime deposit Type of pumps Steam lines?
If fired by waste heat is supply sufficient?
If fired by waste heat regulated? Steam valves?
How is feed water regulated? Average No. on line
How is feed water in turbines? Powdered Coal Gas
Any deposits in turbines?
Avg. boiler pressure? Oil
How are boilers fired? Hand

GENERAL REMARKS

Survey made by

K.W.S.

REG. U.S. PAT. OFF.

SODIUM ALUMINATE

Every K.W.S. sale is based on a scientific survey

K.W.S. sodium aluminate is not just sold—it is serviced. When K.W.S. chemists are convinced that important plant economies can be effected by its use they will recommend it to you. Their opinions are based on a thorough, scientific survey of your boiler plant, source and composition of the raw feed water and method of treating employed at the time. Proper treatment of the raw feed water is prescribed on the basis of the data obtained. Efficient treating of the water is maintained by a simple scientific method developed by this company which enables your engineer at all times to check on the requirements of the feed water. Not only that, but this company, by regular calls of its service men and by mail, sees to it that K.W.S. is being used to produce the results of which it is capable.

K.W.S. sodium aluminate in combination with soda ash and lime, the ordinary chemicals used in external treatment, enables them to react more quickly and completely, leaving a coagulated precipitate which is easily removed by the filters or by the blow-down when treating in the boilers.

When you hear an engineer speak of sodium aluminate, he means K.W.S. sodium aluminate because this is the first solution of sodium aluminate and was made possible by the patented process owned by this company. We will gladly send literature describing the use of this product. Please give your company name, and state whether interested in external or internal treatment.

CHICAGO CHEMICAL CO

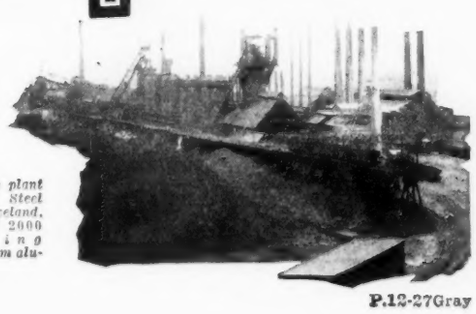
WATER TREATING AND CLARIFYING ENGINEERS

6222 W. 66th Place

CHICAGO

Specialists in water softening, filtration, process work, waste water disposal, and all problems involving water supply and treatment.

Representatives in Principal Cities



Blast furnace plant of the Otis Steel Co., Cleveland, Ohio, one of 2000 plants using K.W.S. sodium aluminate.

P.12-27Gray

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names and Addresses of Manufacturers and Distributors Whose Advertisements Appear in This Issue

See Last Page for Alphabetical Index

Accumulators, Steam
Ruths Accumulator Co., N. Y.

Aftercoolers and Receivers, Air
Alberger Heater Co., Buffalo
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.
Pennsylvania Pump & Compressor Co., Easton

Air Chambers
Hercules Float Wks., Springfield

Air Washers
Connor Co., W. B., N. Y.
Spray Engineering Co., Boston

Alternators, Turbo
Elliott Co., Jeannette, Pa.

Arches, Boiler Door
McLeod & Henry Co., Troy, N. Y.

Arches, Flat, Suspended
Biglow-Liptak Corp., Detroit
Detrick Co., M. H., Chicago
Illinois Stoker Co., Alton, Ill.
McLeod & Henry Co., Troy, N. Y.

Ash Gates and Hoppers for Pulverized Fuel
Allen, Sherman, Hoff Co., Phila

Ash Handling Equipment
Allen, Sherman, Hoff Co., Phila
Beaumont Co., R. H., Phila.
Combustion Engineering Corp., N.Y.
Detrick Co., M. H., Chicago
International Combustion Engrg. Corp., N. Y.
United Conveyors Corp., Chicago

Ash Quenchers
Allen, Sherman, Hoff Co., Phila

Ash Sluicing Systems
Allen, Sherman, Hoff Co., Phila.

Ash Tanks, Tile
United Conveyors Corp., Chicago

Baffle Walls, Boiler
Biglow-Liptak Corp., Detroit
Boiler Engineering Co., Newark
Engineer Co., N. Y.
King Refractories Co., Buffalo
McLeod & Henry Co., Troy, N. Y.
Page Contracting Co., Fred., N. Y.
United States Refractories Co., Mt. Union

Baffles, Monolithic
Boiler Engineering Co., Newark
King Refractories Co., Buffalo
Quigley Furnace Specialties Co., N. Y.

Battery Changing Equipment
Cutler-Hammer Mfg. Co., Milwaukee

Bearings
Hoyt Metal Co., St. Louis
Magnolia Metal Co., N. Y.

Belting
Greene, Tweed & Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
Rhoads & Sons, J. E., Phila.

Belting, Conveyor
Keasbey & Mattison Co., Ambler
Robins Conveying Belt Co., N. Y.

Belting, Leather, Waterproof
Rhoads & Sons, J. E., Phila.

Belting, Rubber
Quaker City Rubber Co., Wissinoming, Phila.

Bins, Coal and Ash
Blaw-Knox Co., Pittsburgh
Industrial-Brownhoist Corp., Cleveland

Blowers, Centrifugal
De Laval Steam Turbine Co., Trenton
Elliott Co., Jeannette, Pa.
Wing Mfg. Co., L. J., N. Y.

Blowers, Fan
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich
Engineer Co., N. Y.
Wing Mfg. Co., L. J., N. Y.

Blowers, Forced Draft
Air Preheater Co., N. Y.
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich
Coppus Engineering Corp., Worcester
McClave-Brooks Co., Scranton, Pa.
Prat-Daniel Corp., N. Y.
Wing Mfg. Co., L. J., N. Y.

Blowers, Hand, Portable
Clements Mfg. Co., Chicago

Blowers, Induced Draft
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich

Blowers, Portable
Clements Mfg. Co., Chicago
Huyette Co., Paul B., Phila.

Blowers, Soot for Boiler Tubes
Diamond Power Specialty Corp., Detroit
Huyette Co., Paul B., Philadelphia
Marion (Ind.) Mach., Fdry. & Supply Co.
Vulcan Soot Cleaner Co., Du Bois

Blowers, Steam Jet
McClave-Brooks Co., Scranton, Pa.

Blowers, Turbine
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford
Wing Mfg. Co., L. J., N. Y.

Boiler Compound
Dearborn Chemical Co., Chicago
Garratt-Callahan Co., Chicago

Boiler Fronts
McClave-Brooks Co., Scranton, Pa

Boiler Insulation
Keasbey & Mattison Co., Ambler

Boiler Setting
Ballard, Sprague & Co., N. Y.
Biglow-Liptak Corp., Detroit
Botfield Refractories Co., Phila.
Cement Gun Co., Allentown
CoKal Stoker Corp., Chicago
Custodis Chimney Constr. Co., Alphons, New York
Detrick Co., M. H., Chicago
Illinois Stoker Co., Alton, Ill.
Keystone Refractories Co., N. Y.
Laclede-Christy, St. Louis
Obermayer Co., S., Chicago
Page Contracting Co., Fred., N. Y.
Queens Run Refractories Co., Lock Haven
Rust Engineering Co., Pittsburgh
United States Refractories Co., Mt. Union

Boiler Tubes
Reading Iron Co., Reading

Boiler Tube Cleaners
(See Blowers, Soot, for Boiler Tube Cleaners)
(See Scale Removers)

Boilers, Locomotive
Connelly Boiler Co., D., Cleveland

Boilers, Return Tubular
CoKal Stoker Corp., Chicago
Connelly Boiler Co., D., Cleveland
Union Iron Works, Erie, Pa.
Vogt Mach. Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga

Boilers, Waste Heat
Combustion Engineering Corp., N.Y.
Edge Moor (Del.) Iron Co
Heine Boiler Co., N. Y.
International Combustion Eng. Corp., N. Y.
Wickes Boiler Co., Saginaw

Boilers, Water Tube, Cross Drum, Horizontal, Inclined, Vertical
Babcock & Wilcox Co., N. Y.
Casey-Hedges Co., Chattanooga
Combustion Engineering Corp., N.Y
Connelly Boiler Co., D., Cleveland
Edge Moor (Del.) Iron Co.
Heine Boiler Co., N. Y.
International Combustion Eng. Corp., N. Y.
Kingsford Fdy. & Mach. Co., Oswego, N. Y.
Ladd Water Tube Boiler Co., Pittsburgh
Springfield (Ill.) Boiler Co.
Union Iron Works, Erie, Pa.
Vogt Machine Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga
Wickes Boiler Co., Saginaw, Mich

Bolts, Nuts, Nickel
American Mond Nickel Co., Pittsburgh

Breechings
Heine Boiler Co., N. Y.

Brick, Fire
Bartley Crucible Co., Jonathan, Trenton
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
Laclede-Christy, St. Louis
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Queens Run Refractories Co., Lock Haven
United States Refractories Co., Mt. Union

Brick, Fire, Cement and Mortar
Quigley Furnace Specialties Co., N. Y.

Buckets, Clam Shell
Blaw-Knox Co., Pittsburgh
Industrial-Brownhoist Corp., Cleveland

Buckets, Elevator
Hendrick Mfg. Co., Carbondale
Robins Conveying Belt Co., N. Y.

Buildings Portable Steel
Blaw-Knox Co. Pittsburgh

Bunkers, Coal
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Industrial-Brownhoist Corp., Cleveland

Burners, Fuel Oil
Peabody Engineering Corp., N. Y.

Burners, Gas
Gas Combustion Co., Pittsburgh
Mettler Co., Lee B., Los Angeles
Peabody Engr. Corp., N. Y.

Burners, Oil
Coen Co., San Francisco
Combustion Service Corp., Brooklyn
Engineer Co., N. Y.
Hammel Oil Burning Equipt. Co., Providence
International Combustion Engrg. Corp., N. Y.

Burners, Powdered Coal
Fuller-Lehigh Co., Fullerton, Pa.
Illinois Stoker Co. Alton
Peabody Engineering Corp., N. Y.

Bushings
Magnolia Metal Co., N. Y.

Castings, Brass and Iron
Neemes Fdry. Inc., Troy

Castings, Grey Iron
Riley Stoker Corp., Worcester

Castings, Nickel
American Mond Nickel Co., Pittsburgh

Cement, Fire Brick
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
Keystone Refractories Co., N. Y.
King Refractories Co., Buffalo
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Quigley Furnace Specialties Co., N. Y.
United States Refractories Co., Mt. Union

Cement, High Temperature
Botfield Refractories Co., Philadelphia
King Refractories Co., Buffalo
Quigley Furnace Specialties Co., N. Y.

Cement, Iron
Obermayer Co., S., Chicago
Smooth-On Mfg. Co., Jersey City

Cement, Pipe Joint
Smooth-On Mfg. Co., Jersey City

Cement Placing Machines
Cement Gun Co., Allentown

Chain Drive
Philadelphia (Pa.) Gear Works

Chains, Nickel
American Mond Nickel Co., Pittsburgh

Chemicals, Water Treating
Chicago (Ill.) Chemical Co.

Chimneys (See Stacks)

Clamps, Pipe
Smooth-On Mfg. Co., Jersey City
Yarnall-Waring Co., Phila.

Clutches, Magnetic
Cutler-Hammer Mfg. Co., Milwaukee

Coal
Peale, Peacock & Kerr, N. Y.
Pittsburgh (Pa.) Coal Co.

Coal Crushers
American Pulverizer Co., St. Louis
Beaumont Co., R. H., Phila.
Combustion Engineering Corp., N.Y.
Fuller Lehigh Co., Fullerton, Pa.
International Combustion Eng. Corp., N. Y.

Coal Feeders, Traveling and Stationary
Robins Conveying Belt Co., N. Y.

Coal Handling Equipment
Beaumont Co., R. H., Phila.
Hunt Co., C. W., West New Brighton, N. Y.
Industrial-Brownhoist Corp., Cleveland
Robins Conveying Belt Co., N. Y.

Coating-Anti-Corrosive
Dampney Co. of America, Boston

Coating, Boiler Tube
Dampney Co. of America, Hyde Park, Boston

Coating, Protective
Dampney Co. of America, Hyde Park, Boston
Quigley Furnace Specialties Co., N. Y.

Cocks, Brass & Iron Body
Homestead (Pa.) Valve Mfg. Co
Walworth Co., Boston

Cocks, Gage
Huyette Co., Paul B., Phila.
Jenkins Bros., N. Y.
Nason Mfg. Co., N. Y.

Cocks, Steam
Dart Mfg. Co., E. M., Providence
Homestead (Pa.) Valve Mfg. Co.
Lunkenheimer Co., Cincinnati
Merco-Nordstrom Valve Co., San Francisco

Combustion Chamber, Back Arch
Detrick Co., M. H., Chicago
McLeod & Henry Co., Troy, N. Y
Obermayer Co., S., Chicago

Combustion Control Systems
Consulting Engineer Co., Pittsburgh
Hagan Corp., Pittsburgh
Smoot Engr. Corp., N. Y.

CO_2 Recorders and Flue Gas Analysis Instruments
Brown Instrument Co., Phila.
Huyette Co., Paul B., Phila.
Republic Flow Meters Co., Chicago

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee
Chicago Pneumatic Tool Co., N. Y.
Gardner Denver Co., Quincy
Ingersoll-Rand Co., N. Y.
Nash Engineering Co., So. Norwalk
Pennsylvania Pump & Compressor Co., Easton, Pa.
Sullivan Machinery Co., Chicago
Worthington Pump & Machinery Corp., N. Y.

Compressors, Gasoline
Sullivan Machinery Co., Chicago

Compressors, Extraction
Sullivan Mchy. Co., Chicago

Condensers, Barometric, Combined, Jet, Surface
Alberger Heater Co., Buffalo
Allis-Chalmers Mfg. Co., Milwaukee
Buffalo (N. Y.) Steam Pump Co.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corp., N. Y.
Ingersoll-Rand Co., N. Y.
Schutte-Koerting Co., Phila.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machinery Corp., N. Y.

Controllers, Draft
Engineer Co., N. Y.

Controllers Electric
Cutler-Hammer Mfg. Co., Milwaukee

Controler, Motor
Cutler-Hammer Mfg. Co., Milwaukee

Converters, Rotary
Elliott Co., Jeanette, Pa.

Converters, Synchronous
Elliott Co., Jeanette, Pa.

Conveyors, Belt
Beaumont Co., R. H., Phila.
Industrial-Brownhoist Corp., Cleveland
Robins Conveying Belt Co., N. Y.

Coolers, Generator
Griscom-Russell Co., N. Y.
Spray Engineering Co., Boston

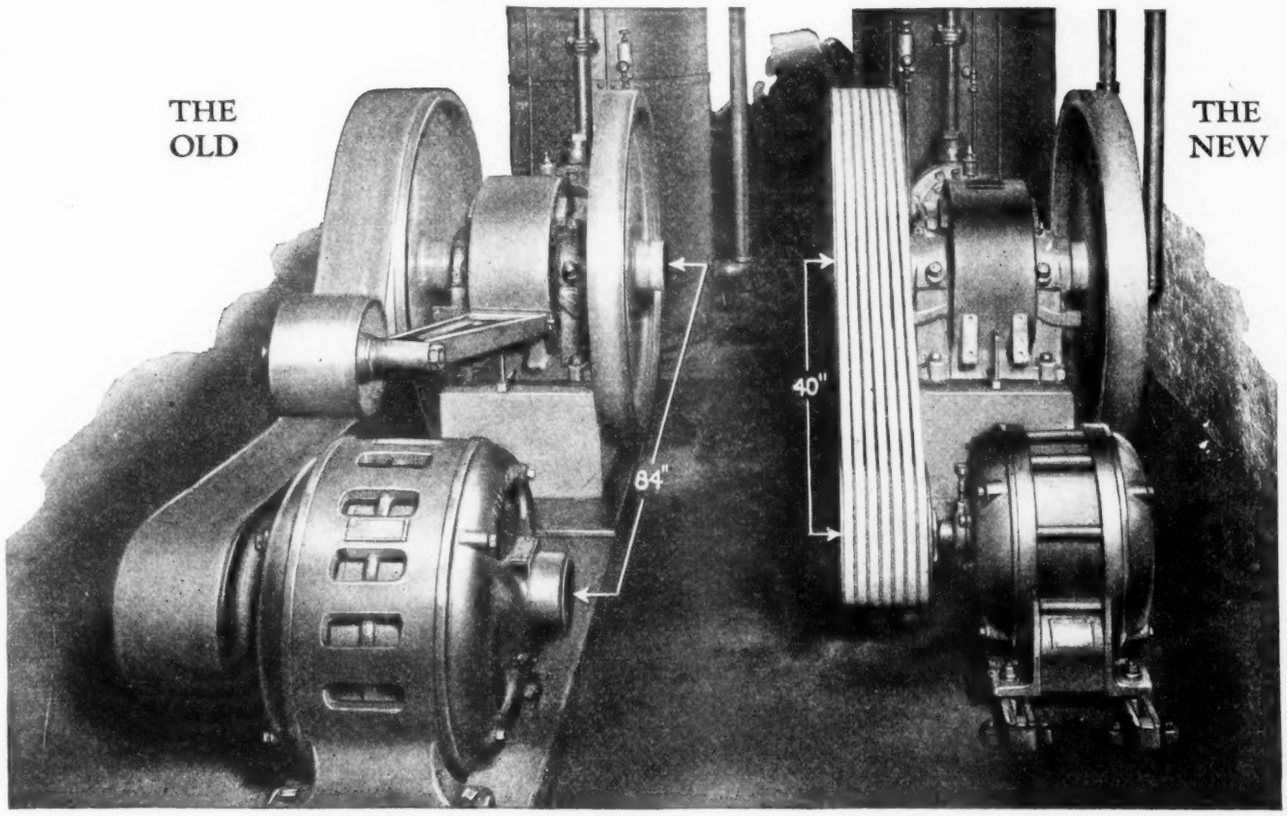
Coolers, Oil
Alberger Heater Co., Buffalo
Griscom-Russell Co., N. Y.

Coolers, Water
Vogt Mach. Co., Henry, Louisville

Cooling Plants and Ponds
Connor Co., W. B., N. Y.
Power Plant Equipment Co., Kansas City, Mo.
Spray Engineering Co., Boston
Yarnall-Waring Co., Phila.

Cooling Towers
Foster Wheeler Corp., N. Y.
Seymour, Jas. M., Newark
Wiederholt Construction Co., St. Louis
Wheeler Mfg. Co., C. H., Phila.

Couplings, Flexible Shaft, Rigid, Shaft
De Laval Steam Turbine Co., Trenton, N. J.
Nicholson & Co., W. H., Wilkes-Barre



Less Power— Less Space— Less Maintenance

Duplicate Compressors, operating at same capacity and pressure.

THE NEW UNIT EMPLOYING TEXROPE ELIMINATES THE IDLER.

The 40″ pulley centers on the new unit is less than one-half of this dimension on the flat belt driven unit.

The short belt centers made possible by Texrope Drive and the compactness of the Allis-Chalmers motor with Timkin Bearings result in a big saving in floor space.

The Texrope requires no lubrication; dust does not affect it. The motor is made largely of steel—indestructible rotor—extra sealed insulation—grease packed bearings which require attention only a few times yearly. These features reduce maintenance to a negligible item.

ALLIS-CHALMERS MANUFACTURING CO.
MILWAUKEE
District Offices in Principal Cities

ALLIS-CHALMERS MOTORS *and* TEXROPE DRIVE

A Combination Unequalled!

Philadelphia (Pa.) Gear Works
Terry Steam Turbine Co., Hartford

Covering, Pipe & Boiler
Keasbey & Mattison Co., Ambler
Obermayer Co., S., Chicago

Cranes
Industrial-Brownhoist Corp., Cleveland

Cranes, Creeper, Type, Locomotive, Gas and Steam
American Hoist & Derrick Co., St. Paul
Industrial-Brownhoist Corp., Cleveland

Cutters, Boiler Tubes
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Underwood Corp., H. B., Phila.

Dampers
Clarage Fan Co., Kalamazoo, Mich

Deaerators
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.

Dealers Machinery
(See Searchlight Section)
Davis, J. F.
Gregory Electric Co.
Hitner & Sons Co., Henry
Jarvis, D.
Land, L. J.
National Power Mchy. Co.
O'Brien Mchy. Co.
Phoenix Utility Co.
Power Plant Equipment Co.
Randle Mchy. Co.
Ross Power Equipment Co.
Sachsenmaier, Geo.
Stewart & Co., Paul
Wickes Machinery Co.

Desuperheaters
Elliott Co., Jeanette, Pa.

Die Stocks
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Mach

Distilling Apparatus (Water)
Griscom-Russell Co., N. Y.

Draft, Mechanical
(See Blowers, Fan)

Drainers, Low Pressure
Cochrane Corp., Phila.

Dressing, Belt
Rhoads & Sons, J. E., Phila.

Drills
Chicago Pneumatic Tool Co., N. Y.

Drop Forgings
Ingersoll-Rand Co., N. Y.
Vogt Mach. Co., Henry, Louisville

Dynamometers
Wheeler Mfg. Co., C. H., Phila.

Dynamos (See Generators)

Economizers
Alberger Heater Co., Buffalo
Foster Wheeler Corp., N. Y.
Green Fuel Economizer Co., Beacon, N. Y.

Ejectors
Chaplin-Fulton Mfg. Co., Pittsburgh
Elliott Co., Jeanette, Pa.
Nash Engineering So., So. Norwalk
Penberthy Injector Co., Detroit

Electors, Air
Elliott Co., Jeannette, Pa.
Wheeler Mfg. Co., C. H., Phila.

Electric Generating Sets, Steam Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Jeannette, Pa.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford

Elevators and Conveyors
Beaumont Co., R. H., Phila.
Industrial-Brownhoist Corp., Cleveland

Elevators and Elevator Service
Otis Elevator Co., New York

Engine Generators
Elliott Co., Jeanette, Pa.

Engine Repairs
Underwood Corp., H. B., Phila.

Engines, Corliss
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Jeanette, Pa.

Engines, Diesel
Busch-Sulzer Bros.-Diesel Engine Co., St. Louis
Lombard Governor Co., Ashland Mass.
McIntosh & Seymour Corp., Auburn
Worthington Pump & Machinery Corp., N. Y.

Engines, Gas and Oil
Allis-Chalmers Mfg. Co., Milwaukee
Busch-Sulzer Bros.-Diesel Engine Co., St. Louis
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.
Sterling Engine Co., Buffalo
Worthington Pump & Machinery Corp., N. Y.

Engines, Poppet-Valve
Elliott Co., Jeanette, Pa.

Engines, Steam
Air Preheater Corp., N. Y.
Allis-Chalmers Mfg. Co., Milwaukee
Clarage Fan Co., Kalamazoo, Mich
Elliott Co., Jeanette, Pa.
Skinner Engine Co., Erie
Troy (Pa.) Engine & Machine Co.

Engines, Steam Una-Flow
Elliott Co., Jeanette, Pa.
Skinner Engine Co., Erie

Evaporators
Foster Wheeler Corp., N. Y.
Griscom-Russell Co., N. Y.

Exhaust Heads
Hoppes Mfg. Co., Springfield, Ohio
Watson & McDaniels Co., Philadelphia
Wright-Austin Co., Detroit

Expansion Joints
Elliott Co., Jeanette, Pa.
Foster Wheeler Corp., N. Y.
Grinnell Co., Providence
Griscom-Russell Co., N. Y.
Howard Iron Wks., Buffalo
Wheeler Mfg. Co., C. H., Phila.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Fans, Forced Draft
Coppus Engineering Corp., Worcester
Green Fuel Economizer Co., Beacon

Feed Water Treatment
Chicago (Ill.) Chemical Co.

Filters, Air
Connor Co., W. B., N. Y.

Filters, Feed Water, Pressure—Water
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.

Filters, Oil
Elliott Co., Jeannette, Pa.
Nugent & Co., Wm. W., Chicago

Filters, Oil Removal
Elliott Co., Jeanette, Pa.
Griscom-Russell Co., N. Y.

Filters, Oil System
Nugent & Co., Wm. W., Chicago

Firebox Blocks
McLeod & Henry Co., Troy, N. Y.
United States Refractories Co., Mt. Union

Fire Hydrants
Howard Iron Wks., Buffalo

Fittings, Ammonia
Greene, Tweed & Co., N. Y.
Vogt Machine & Co., Henry, Louis-York (Pa.) Ice Machy. Co.

Fittings, Steel
Pittsburgh (Pa.) Piping & Equip Co.

Flanges
Dart Mfg. Co., E. M., Providence
Grinnell Co., Providence
Jefferson Union Co., Lexington.
Jenkins Bros., N. Y.
Pittsburgh (Pa.) Piping & Equip Co.
Power Piping Co., Pittsburgh
Vogt Machine Co., Henry, Louisville

Floats
Hercules Float Wks., Springfield, Mass.

Flooring, Fireproof
Tri Lok Co., The, Pittsburgh

Flooring, Non-Slipping
Tri Lok Co., The, Pittsburgh

Flooring, Open-Steel
Tri Lok Co., The, Pittsburgh

Flooring, Steel
Littleford Bros., Cincinnati
Tri-Lok Co., The, Pittsburgh

Flooring, Ventilating
Tri Lok Co., The, Pittsburgh

Flue Gas Analysis Instruments
Huyette Co., Paul B., Phila.

Forgings, Nickel
American Mond Nickel Co., Pittsburgh

Foundations, Machinery
Ballard, Sprague & Co., N. Y.

Fuel Oil Systems
Coen Co., San Francisco
Combustion Engineering Corp., N. Y.
Engineer Co., N. Y.
Hammel Oil Burning Equipt. Co. Providence
International Combustion Engr. Corp., N. Y.
Peabody Engineering Corp., N. Y.

Furnace Arches
Piglow-Liptak Corp., Detroit
Detrick Co., M. H., Chicago
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Queens Run Refractories Co., Lock Haven
United States Refractories Co., Mt. Union

Furnace Bottoms, Cast Iron Air Cooled
Allen, Sherman, Hoff Co., Phila

Furnace Construction
Cement Gun Co., Allentown

Furnace Linings
Botfield Refractories Co., Phila.
Cement Gun Co., Allentown
General Refractories Co., Phila.
Keystone Refractories Co., N. Y.
Laclede-Christy, St. Louis
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Queens Run Refractories Co., Lock Haven
United States Refractories Co., Mt. Union

Furnace Walls, Water Cooled
Combustion Eng. Corp., N. Y.
Foster Wheeler Corp., N. Y.
International Combustion Eng. Corp., N. Y.

Furnaces
Combustion Engineering Corp., N. Y.
Detroit (Mich.) Stoker Co.
Fuller Lehigh Co., Fullerton, Pa.
Illinois Stoker Co., Alton, Ill.
International Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa

Furnaces, Bagasse & Wood Burning
Combustion Engineering Corp., N. Y.
Detrick Co., M. H., Chicago
International Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa

Furnaces, Incinerator
Combustion Engineering Corp., N. Y.
International Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa

Gage Glass Guards & Shields
Huyette Co., Paul B., Phila.
Jenkins Bros, N. Y.
Wright Austin Co., Detroit

Gage Glasses
Chesterton Co., A. W., Boston
Durabla Mfg. Co., N. Y.
Jenkins Bros, N. Y.
Libbey Glass Mfg. Co., Toledo

Gages, Differential, Draft, Liquid Depth, Pressure, Recording Vacuum, Water
American Schaeffer & Budenberg Corp., Brooklyn
Bailey Meter Co., Cleveland
Bristol Co., Waterbury
Brown Instrument Co., Phila.
Crosby Steam Gage & Valve Co., Boston
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Republic Flow Meters Co., Chicago
Yarnall-Waring Co., Philadelphia

Gas Burning Equipment
Coen Co., San Francisco
Mettler Co., Lee B., Los Angeles
Peabody Engineering Corp., N. Y.

Gaskets
Advance Packing & Supply Co., Chicago
General Asbestos & Rubber Co., No. Charleston
Garlock Packing Co., Palmyra, N. Y
Greene, Tweed & Co., N. Y
Jenkins Bros., N. Y.
Keasbey & Mattison Co., Ambler
Quaker City Rubber Co., Wissinoming, Phila.
Smooth-On Mfg. Co., Jersey City, N.J

Gates, Air Blast
McClave-Brooks Co., Scranton.

Gates, Coal & Ash Bin
Allen, Sherman, Hoff Co., Phila
Beaumont Co., R. H., Phila.
Hunt Co., C. W., West New Brighton N. Y.
Industrial-Brownhoist Corp., Cleveland

Gears
Philadelphia (Pa.) Gear Works

Gears, Double Helical
De Laval Steam Turbine Co., Trenton, N. J.

Gears, Reduction
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
Moore Steam Turbine Corp., Wellsville, N. Y.
Philadelphia (Pa.) Gear Works
Terry Steam Turbine Co., Hartford

Generating Sets
Elliott Co., Jeanette, Pa.

Generators, Electric
Elliott Co., Jeanette

Governors, Engine
Gardner-Denver Co., Quincy

Governors, Pressure
Northern Equipment Co., Erie

Governors, Pump
Atlas Valve Co., Newark
Chaplin-Fulton Mfg. Co., Pittsburgh
Northern Equipment Co., Erie
Watts Regulator Co., Lawrence

Governors, Water-Wheel
Lombard Governor Co., Ashland

Graphite
Greene, Tweed & Co., N. Y
United States Graphite Co., Saginaw

Grates
Riley Stoker Corp., Worcester

Grate Bars & Clips
Riley Stoker Corp., Worcester

Grates, Dumping
Auburn (Ind.) Stoker Corp.
Babcock & Wilcox Co., N. Y
CoKal Stoker Corp., Chicago
Combustion Eng. Corp., N. Y.
Cyclone Grate Bar Co., Buffalo
International Combustion Engineering Corp., N. Y.
Kelly Foundry & Mach. Co., Goshen
McClave-Brooks Co., Scranton, Pa
Marion (Ind.) Mach., Fdry. & Supply Co.
Neemes Fdry., Inc., Troy
Vogt Mach. Co., Henry, Louisville

Grates, Shaking
Auburn (Ind.) Stoker Corp.
Babcock & Wilcox Co., N. Y.
CoKal Stoker Corp., Chicago
Combustion Eng. Corp., N. Y.
Cyclone Grate Bar Co., Buffalo
International Combustion Engineering Corp., N. Y.
Kelly Foundry & Mach. Co., Goshen
McClave-Brooks Co., Scranton, Pa
Marion (Ind.) Mach., Fdry. & Supply Co.
Neemes Fdry., Inc., Troy
Vogt Mach. Co., Henry, Louisville

Grates, Stationary
Auburn (Ind.) Stoker Corp.
Babcock & Wilcox Co., N. Y.
CoKal Stoker Corp., Chicago
Combustion Eng. Corp., N. Y.
Cyclone Grate Bar Co., Buffalo
International Combustion Engineering Corp., N. Y.
Kelly Foundry & Mach. Co., Goshen
McClave-Brooks Co., Scranton, Pa.
Marion (Ind.) Mach., Fdry. & Supply Co.
Neemes Fdry., Inc., Troy
Vogt Mach. Co., Henry, Louisville

Grating, Steel
Blaw-Knox Co., Pittsburgh
Tri-Lok Co., Pittsburgh

Grease
Vacuum Oil Co., New York

Grease Extractors
Elliott Co., Jeannette, Pa.

Grinders, Air & Elect., Portable
Chicago Pneumatic Tool Co., N. Y.

Grizzlies
Robins Conveying Belt Co., N. Y.

Guns, Cement and Refractory
Botfield Refractories Co., Phila.
Cement Gun Co., Allentown
Quigley Furnace Specialties Co., N. Y.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.

Heat Exchangers
Wheeler Mfg. Co., C. H., Phila.

Heaters, Air
Air Preheater Co., N. Y.
Babcock & Wilcox Co., N. Y.
Combustion Engineering Corp., N. Y
Foster Wheeler Corp., N. Y.
International Combustion Engr. Corp., N. Y.
Prat-Daniel Corp., N. Y.

Heaters, Deaerating
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.

Heaters, Domestic
Alberger Heater Co., Buffalo

Heaters, Feed Water
Alberger Heater Co., Buffalo
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corp., N. Y.
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Neemes Fdry., Troy, N. Y.
Patterson-Kelley Co., N. Y.
Schutte-Koerting Co., Phila.
Wheeler Mfg. Co., C. H., Phila.

Heaters, Hot Water Service
Patterson-Kelley Co., N. Y.

Heaters, Metering
Cochrane Corp., Phila.

Heaters, Oil
Alberger Heater Co., Buffalo
Coen Co., San Francisco
Griscom-Russell Co., N. Y.
Hammel Oil Burning Equipt. Co. Providence
Patterson-Kelley Co., N. Y.

Heaters, Steam Stack
Cochrane Corp., Phila.

Heaters, Storage
Cochrane Corp., Phila.
Patterson-Kelley Co., N. Y.

Heating and Ventilating Systems
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich

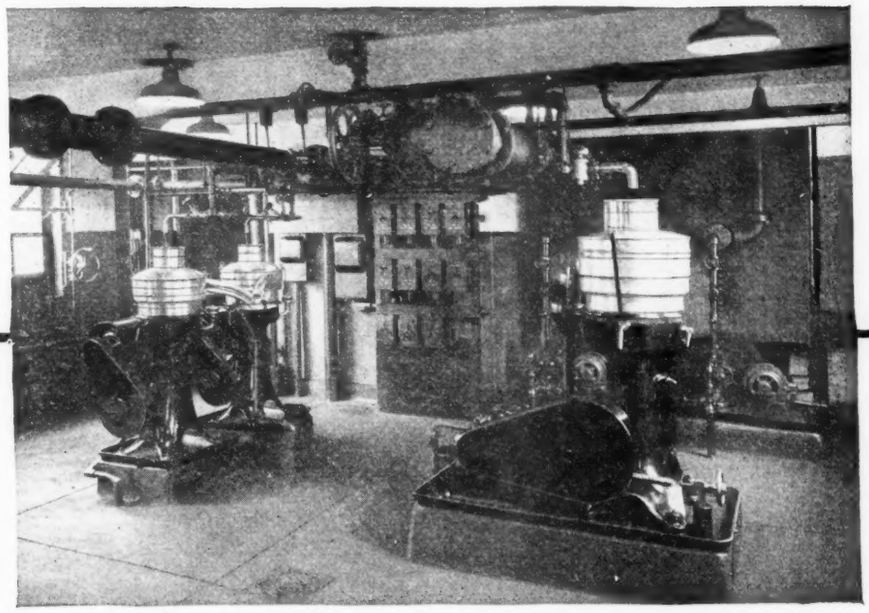
Hoists, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio

Hoists, Electric
Beaumont Co., R. H., Phila.

Hoists, Portable
Sullivan Machinery Co., Chicago

Hoists, Steam
Sullivan Machinery Co., Chicago

Hoppers, Coal and Ash
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.



Oil room and three De Laval Purifiers at Hudson Avenue Generating Station of the Brooklyn Edison Company, Brooklyn, N. Y.

Keeping turbine oil clean at Hudson Avenue

Further safeguarding the efficient and dependable operation of turbo-generators at the Brooklyn Edison Company's new Hudson Avenue Station, three De Laval Oil Purifiers continuously remove from the lubricating oil, sludge, water and other impurities which are the usual cause of bearing trouble.

A portion of the oil in circulation is continuously by-passed to the purification plant above the turbine floor, going first through bag filters and then to the Purifiers, where the last traces of moisture and dirt are removed.

That's the beauty of centrifugal purification —the reason De Laval Purifiers are now used by more than 80% of America's largest power systems—it is a complete process in itself or a finishing step as you wish. However employed it seldom, if ever, leaves anything further to be desired. The Brooklyn Edison Company's experience with De Laval has been such that eight of them are now in use on the system—transformer oil, as well as lubricating oil, being centrifugally purified.

The De Laval Engineering Department will be glad to cooperate with you in order that you may have the same kind of lubricating and transformer oil which helps keep this well-known power system operating so smoothly. In writing for further information please ask for Bulletin 106-P on lubricating oil or Bulletin 107-P on insulating oil.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 600 Jackson Blvd., Chicago
DE LAVAL PACIFIC COMPANY, San Francisco
ALFA-LAVAL CO., Ltd., 34 Grosvenor Road, London, S. W. 1.

De Laval Oil Purifiers

Types for Lubricating Oil Fuel Oil, Transformer and Circuit Breaker Oil, Crankcase Oil

O-732-L

Combustion Eng. Corp., N. Y.
International Combustion Engr. Corp., N. Y.

Hose, Rubber, For Air, Steam, Tube Cleaners, Water
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Jeannette
Quaker City Rubber Co., Wissinoming, Phila.

Ice Machine Repairs
Underwood Corp., H. B., Phila.

Ice and Refrigerating Machinery
(See Refrigerating Machinery)

Idlers, Conveyor
Robins Conveying Belt Co., N. Y.

Indicators, Combustion
Brown Instrument Co., Phila.

Indicators, Speed
Biddle, James G., Phila.
Graybar Electric Co., N. Y.
Zernickow Co., O., N. Y.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston

Indicators, Valve Position
Cutler-Hammer Mfg. Co., Milwaukee
Northern Equipment Co., Erie

Injectors
Jenkins Bros., N. Y.
Penberthy Injector Co., Detroit

Intercoolers
Griscom-Russell Co., N. Y.

Lubricants
Vacuum Oil Co., New York

Lubricators, Cylinder
Bowser & Co., S. F., Ft. Wayne
Greene, Tweed & Co., N. Y.
Lunkenheimer Co., Cincinnati

Lubricators, Force Feed
Bowser & Co., S. F., Ft. Wayne
Greene, Tweed & Co., N. Y.
Penberthy Injector Co., Detroit

Machine Screws, Nickel
Beaumont Co., R. H., Phila.

Machine, Work Special
Howard Iron Wks., Buffalo

Metal, Bearing
Hoyt Metal Co., St. Louis
Magnolia Metal Co., N. Y.

Metal, Sheets, Rods, Castings
American Mond Nickel Co., Pittsburgh

Meters, Air, Boiler, Flow, Gas, Oil, Water, Steam
Elliott Co., Jeanette, Pa.
Bailey Meter Co., Cleveland
Brown Instrument Co., Phila.
Cochrane Corp., Phila.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago
Worthington Pump & Machinery Corp., N. Y.
Yarnall-Waring Co., Phila.

Meters, Coal
Bailey Meter Co., Cleveland
Republic Flow Meters Co., Chicago

Meters V-Notch
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Volumetric
Cochrane Corp., Phila.
Yarnall-Waring Co., Philadelphia

Meters, Weighing
Cochrane Corp., Phila.

Motor Generators
Elliott Co., Jeanette, Pa.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Jeanette, Pa.

Motors, Synchronous
Elliott Co., Jeanette, Pa.

Motors, Water
Roto Co., Newark

Nickel, Sheets, Rod & Castings
American Mond Nickel Co., Pittsburgh

Oil and Grease Cups
Lunkenheimer Co., Cincinnati
Penberthy Injector Co., Detroit

Oil, Lubricating
Dearborn Chemical Co., Chicago
Vacuum Oil Co., New York

Oil Reclaimers
Bowser & Co., S. F., Ft. Wayne
De Laval Separator Co., N. Y.

Oil Storage Equipment
Bowser & Co., S. F., Fort Wayne, Ind.

Oilers, Sight Feed and Multiple
Bowser & Co., S. F., Ft. Wayne
Nugent & Co., Wm. W., Chicago

Oilers, Telescopic and Centrifugal
Bowser & Co., S. F., Ft. Wayne

Oiling Devices and Systems
Bowser & Co., S. F., Ft. Wayne
Nugent & Co., Wm. W., Chicago

Packing, Asbestos
Advance Packing & Supply Co., Chicago
Durabla Mfg. Co., N. Y.
Garlock Packing Co., Palmyra, N. Y
General Asbestos & Rubber Co., No. Charleston
Greene, Tweed & Co., N. Y.
Keasbey & Mattison Co., Ambler

Packing, Cylinder, Hydraulic, Piston, Rod, Sheet, Valve Stem, Pump Valve
Advance Packing & Supply Co., Chicago
Alfit Packing Co., N. Y.
Chesterton Co., A. W., Boston
Durabla Mfg. Co., N. Y.
Garlock Packing Co., Palmyra, N. Y
General Asbestos & Rubber Co., No. Charleston
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.

Packing, Flax
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y
General Asbestos & Rubber Co., No. Charleston
Greene, Tweed & Co., N. Y.

Packing, Metallic
Alfit Packing Co., N. Y.
Conneaut Packing Co., Conneaut
Durabla Mfg. Co., N. Y.
France Packing Co., Philadelphia
Garlock Packing Co., Palmyra, N. Y

Packing Metallic Flexible
France Packing Co., Philadelphia
Garlock Packing Co., Palmyra, N. Y

Packing, Plastic, Metallic
Alfit Packing Co., N. Y.
Conneaut Packing Co., Conneaut

Paints, Anti-Corrosive
Dampney Co. of America, Hyde Park, Boston
Quigley Furnace Specialties Co., N. Y.

Paints, Heat Resisting
Dampney Co. of America, Hyde Park, Boston

Paints, Industrial
Quigley Furnace Specialties Co., N. Y.

Paints Metal
Dampney Co. of America, Hyde Park, Boston

Paints, Rust Proofing
Dampney Co. of America, Hyde Park, Boston
Dearborn Chemical Co., Chicago

Paints Steel Preservative
Dampney Co. of America, Hyde Park, Boston

Pipe
Byers Co., A. M., Pittsburgh
Grinnell Co., Providence
Power Piping Co., Pittsburgh

Pipe Bending
American Pipe Bending Mach. Co., Boston
Grinnell Co., Providence
Power Piping Co., Pittsburgh

Pipe Coils
Abendroth & Root Mfg. Co., N. Y.

Pipe Cutting and Threading Machines
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Mach. Co.

Pipe Fittings
Grinnell Co., Providence
Jefferson Union Co., Lexington
Pittsburgh (Pa.) Piping & Equip. Co.
Power Piping Co., Pittsburgh
Walworth Co., Boston

Pipe Spiral, Riveted
Abendroth & Root Mfg. Co., N. Y.

Pipe, Wrought Iron
Byers Co., A. M., Pittsburgh

Piping Contractors
Baker Co., R. H., Cambridge
Grinnell Co., Providence
Pittsburgh (Pa.) Piping & Equip. Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh
Simmons Co., John, New York City

Piping, High Pressure
Baker Co., R. H., Cambridge
Byers Co., A. M., Pittsburgh
Pittsburgh (Pa.) Piping & Equip. Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh

Pneumatic Tools
Ingersoll-Rand Co., N. Y.

Power Transmission Machinery
Allis-Chalmers Mfg. Co., Milwaukee

Pre-Heaters, Air
Air-Preheater Corp., N. Y.
Buffalo Forge Co., Buffalo
Combustion Engineering Corp., N. Y.
Foster Wheeler Corp., N. Y.
Green Fuel Economizer Co., Beacon
International Combustion Engineering Corp., N. Y.
Prat-Daniel Corp., N. Y.

Pulleys
Greene, Tweed & Co., N. Y.

Pulverized Coal Equipment
Combustion Engineering Corp., N. Y.
Foster Wheeler Corp., N. Y.
Illinois Stoker Co., Alton
International Combustion Engr. Corp., N. Y.

Peabody Engineering Corp., N. Y.
Riley Stoker Corp., Worcester

Pump Liners, Nickel
American Mond Nickel Co., Pittsburgh

Pump Rods, Nickel
American Mond Nickel Co., Pittsburgh

Pumps, Air
Elliott Co., Jeannette, Pa.
Foster Wheeler Corp., N. Y.
Wheeler Mfg. Co., C. H., Phila.

Pumps, Air Lift
Pennsylvania Pump & Compressor Co., Easton, Pa.

Pumps, Centrifugal
Aldrich Pump Co., Allentown
Allis-Chalmers Mfg. Co., Milwaukee
Buffalo Steam Pump Co., Buffalo
Chicago (Ill.) Pump Co.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.
Lecourtenay Co., Newark, N. J.
Manistee (Mich.) Iron Works Co.
Moore Steam Turbine Corp., Wellsville, N. Y.
Nash Engineering So., So. Norwalk
Pennsylvania Pump & Compressor Co., Easton, Pa.
Terry Steam Turbine Co., Hartford
Westco-Chippewa Pump Co., Davenport, Ia.
Worthington Pump & Machinery Corp., N. Y.
Wheeler Mfg. Co., C. H., Phila.

Pumps, Condensate
Chicago (Ill.) Pump Co.
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co. (Cameron Steam Pump Wks., A. S.), N. Y.

Pumps, Deep Well
Westco-Chippewa Pump Co., Davenport, Iowa
Worthington Pump & Machinery Corp., N. Y.

Pumps, Oil
Coen Co., San Francisco
Hammel Oil Burning Equipt. Co. Providence
Lunkenheimer Co., Cincinnati
Nugent & Co., Wm. W., Chicago
Schutte & Koerting Co., Phila.

Pumps, Power
Aldrich Pump Co., Allentown, Pa.
Gardner-Denver Co., Quincy
Platt Iron Works, Dayton, Ohio
Westco-Chippewa Pump Co., Davenport, Ia.
Worthington Pump & Machinery Corp., N. Y.

Pumps, Reciprocating
Aldrich Pump Co., Allentown, Pa.
Allis-Chalmers Mfg. Co., Milwaukee
Buffalo (N. Y.) Steam Pump Co.
Gardner-Denver Co., Quincy
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.
Manistee (Mich.) Iron Works Co.
Platt Iron Works, Dayton
Westco-Chippewa Pump Co., Davenport, Ia.
Worthington Pump & Machinery Corp., N. Y.

Pumps, Rotary
Wheeler Mfg. Co., C. H., Phila.

Pumps, Sump
Worthington Pump & Machinery Corp., N. Y.

Pumps, Vacuum
Chicago (Ill.) Pump Co.
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.
Sullivan Machinery Co., Chicago
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machinery Corp., N. Y.

Purifiers, Feed Water
Cochrane Corp., Phila., Pa.
Griscom-Russell Co., N. Y.
Hagan Corp., Pittsburgh
Hoppes Mfg. Co., Springfield, Ohio
Yarnall-Waring Co., Phila., Pa.

Purifiers, Oil
De Laval Separator Co., N. Y.

Purifiers, Steam
Andrews-Bradshaw Co., Pittsburgh

Pyrometers
Bristol Co., Waterbury
Brown Instrument Co., Phila.
Leeds & Northrup Co., Phila.
Republic Flow Meters Co., Chicago
Taylor Instrument Co.'s, Rochester

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Mason Regulator Co., Boston
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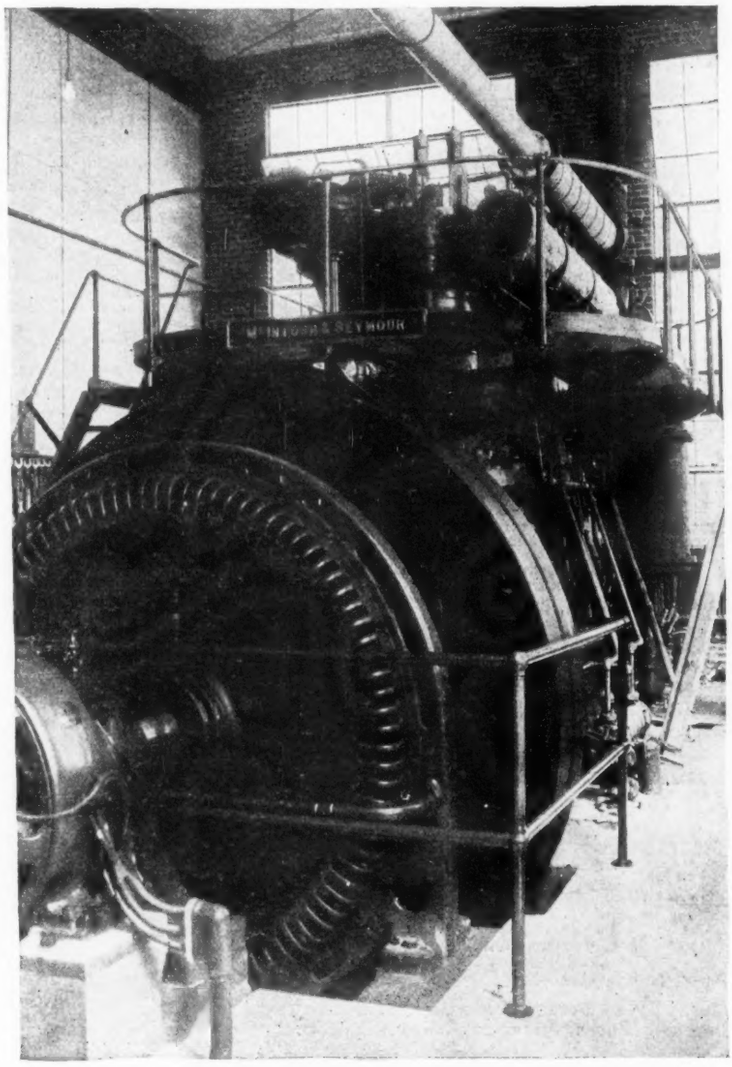
Diesel power—the remedy in an overloaded or inefficient steam-driven pumping plant

THE White Plains plant of New York Water Service Corporation (a subsidiary of the Federal Water Service Corporation) furnishes water to White Plains and Castle Heights at wholesale, serves a few local customers at retail, and provides water for locomotives in the North White Plains yards of the New York Central Railroad.

Arrangements had been made by previous owners to install a new boiler and new triple-expansion pumping engine of two million gal. per day capacity, this engine to be located in a deep pit with direct suction from a series of new wells.



300-B.hp. McIntosh & Seymour Diesel Engine at White Plains plant, N. Y. Water Service Corporation

The new owners, under direction of L. A. Phillips, Vice-President, rejected these plans as expensive and wasteful in operation and instead erected a new power house with 300-b.hp. McIntosh & Seymour Diesel Engine direct-connected to a 250-kva. generator. By so doing, electric power could be taken to wells wherever located, and the well area could be developed to its maximum water output.

Two motor-driven deep-well centrifugal pumping units were installed, one in a new well, and the other in an old well that had not been used because the suction lift there was too great for the old steam equipment.

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The McIntosh & Seymour Diesel Engine is doing everything that could be expected and has proven entirely satisfactory.

Judicious use of Diesel power to supplant or assist overloaded or inefficient old steam units is in most instances a very desirable way to increase capacity and reduce unit producing costs. Tell us your conditions so our Engineers can submit facts and figures.

Capacities 80 to 10,000 b.hp. in stationary types suitable for central station, municipal lighting, waterworks and industrial power.

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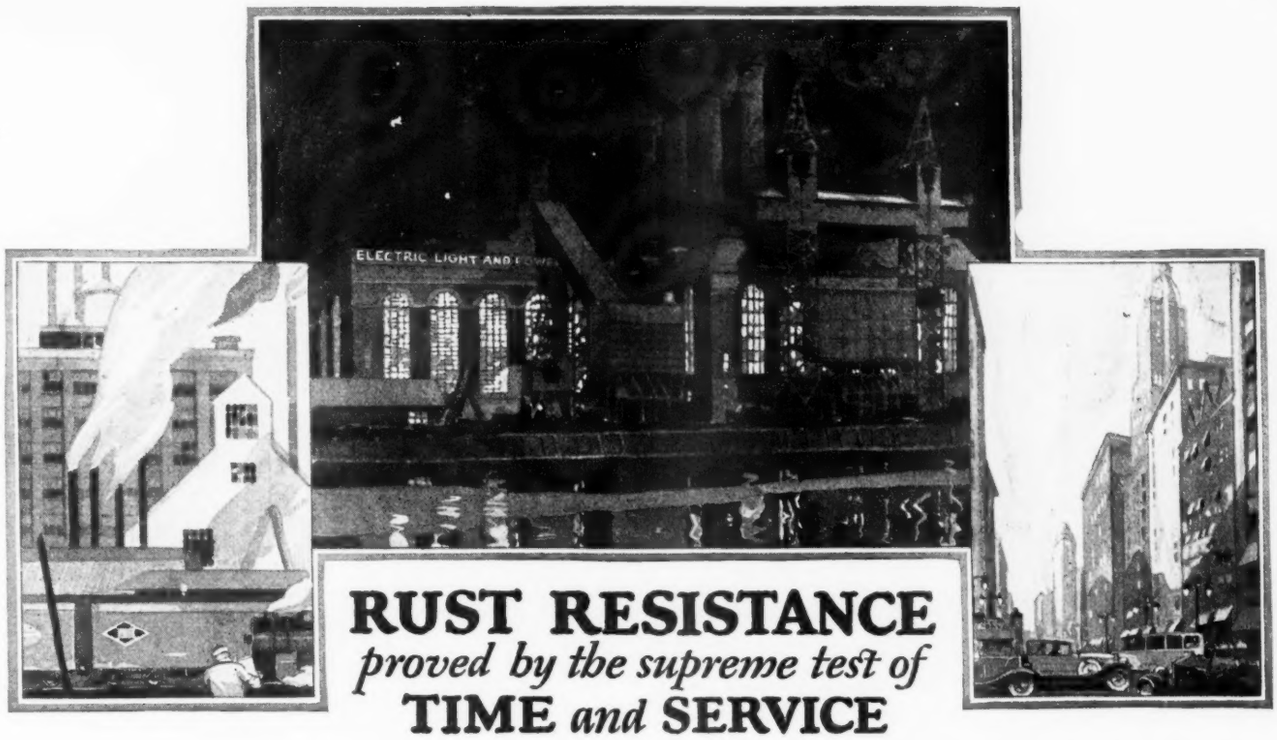


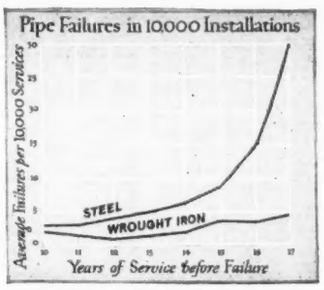
RUST RESISTANCE
proved by the supreme test of TIME *and* SERVICE

NOT argument but the evidence of use; not quick findings from short time corrosion tests but the records of long practical experience are the foundations of confidence in Byers Pipe.

The chart here given summarizes a considerable body of such experience. A public service corporation made comparative tables covering pipe failures of wrought iron pipe and steel pipe in its extensive gas lines, for seventeen years. The percentage of failures for wrought iron, throughout the entire period, remained uniformly low, whereas the failures of steel pipe increased at an alarming rate after the fourteenth year.

The observed difference of behavior is due to known causes. At first, rust attacks all ferrous materials alike. Wrought iron, cast iron, steel—they are all alike subject to corrosion. In wrought iron, however, the native slag filaments stand as protective barriers. When the mass of iron begins to rust, more and more of these non-rusting silicate particles, coming to the surface, are opposed to the corrosive attack; and the destructive process is arrested. This is the peculiar virtue of wrought iron.

Explanations, however, are less important than facts.



Note the small number of failures of wrought iron pipe throughout the 17-year period, and the rapidly increasing rate of failures of steel pipe after the 14th year.

Time reveals the practical difference between various kinds of pipe in use. Corrosive tests in a laboratory may indicate something but when they contradict the plain facts of experience, obviously they are of little value.

Byers Pipe is preferred and used, not so much by the casual small buyer of such materials as by important industrial and business corporations, employing expert advice. Far the greater part of all Byers pipe sold, is bought on the specification or counsel of seasoned engineers and architects.

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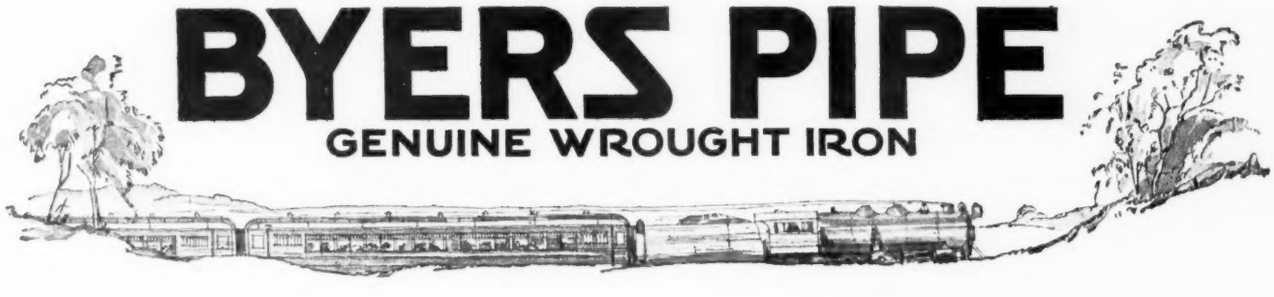

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